Biology Dept. Library

Duke University Library

OCT 15 1943

Durham, N. C.

Volume XXXVI Number 3

ANNALS

OF

The Entomological Society of America

SEPTEMBER, 1943

HERBERT OSBORN, *Editor Emeritus*

EDITORIAL BOARD

CLARENCE H. KENNEDY, Managing Editor,
COLUMBUS, OHIO

DONALD J. BORROR, Assistant Managing Editor,
COLUMBUS, OHIO

1943	1944	1945
ARTHUR GIBSON, OTTAWA, CANADA.	C. P. ALEXANDER, AMHERST, MASS.	F. M. CARPENTER, CAMBRIDGE, MASS.
T. H. HUBBELL, GAINESVILLE, FLA.	HARRY H. KNIGHT, AMES, IOWA.	WILLIAM PROCTER, BAR HARBOR, ME.
GEO. F. KNOWLTON, LOGAN, UTAH.	PAUL S. WELCH, ANN ARBOR, MICH.	E. M. WALKER, TORONTO, CANADA.

PUBLISHED QUARTERLY BY THE SOCIETY
COLUMBUS, OHIO

Entered as second-class matter April 11, 1908, at the Post Office at Columbus, Ohio, under the act of Congress of March 3, 1879. Subject to rate of postage provided for in Paragraph 4, Section 538, P. L. & R., authorized September 16, 1940.

The Entomological Society of America

Founded 1906

OFFICERS 1943

President

CHARLES P. ALEXANDER . . . . . Amherst, Massachusetts

First Vice-President

MIRIAM A. PALMER . . . . . Fort Collins, Colorado

Second Vice-President

WILLIAM T. DAVIS . . . . . Staten Island, New York

Secretary-Treasurer

CLARENCE E. MICKEL . . . . . St. Paul, Minnesota

Managing Editor, Annals

CLARENCE H. KENNEDY . . . . . Columbus, Ohio

Executive Committee

THE OFFICERS

AND

1943	1944	1945
A. C. KINSEY	C. F. W. MUESEBECK	M. H. HATCH
WILLIAM P. HAYES		T. B. MITCHELL

Thomas Say Foundation

J. J. DAVIS, *Editor and Treasurer*

1943	1944
A. C. KINSEY	T. H. FRISON
E. O. ESSIG	C. F. W. MUESEBECK

ANNALS
OF
The Entomological Society of America

Volume XXXVI SEPTEMBER, 1943 No. 3

NEW SPECIES OF HALICTOPHAGUS WITH A KEY TO THE GENUS IN NORTH AMERICA

(Strepsiptera, Halictophagidae)

RICHARD M. BOHART,
University of California,
Los Angeles, California

Since the publication of the writer's revision of the Strepsiptera[1] enough material has been studied, principally through the cooperation of P. W. Oman, of the U. S. National Museum, to warrant a synopsis of the genus *Halictophagus* Curtis. A generic synonymy has been previously published.[1] The genus is characterized as follows:

Parasites of leafhoppers, fulgorids, and treehoppers. Distribution world-wide.

Male.—Antenna seven-segmented, the last five segments laterally flabellate, compact, basal portion of the segments less than three times as long as broad; tibiae differentiated into a pseudo-segment near the base; tarsi three-segmented.

Female.—Head comprising half to two-thirds of the cephalothorax; mandible with one or two apical teeth; first abdominal sternite with more or less definite pigmented area connected with the cephalothorax; abdomen with one to four genital openings.

Satisfactory determination of *Halictophagus* can be made only from specimens properly mounted on microscope slides. The writer has had good success soaking the abdomen of the host overnight in cold 5 per cent potassium hydroxide; dissecting out the parasite; washing it for several hours in water; dehydrating it by successive 15-minute baths in 25 per cent, 50 per cent, 75 per cent, and 95 per cent alcohol; and mounting it directly in euparal or through clove oil into balsam. Females should be mounted ventral side up. To avoid crushing the male, the coverslip can be raised on broken pieces of coverslip to the desired height, or circles or bristle-board previously impregnated with the mounting medium can be used. The male aedeagus should first be dissected off and mounted on its side under a separate coverslip.

[1]Bohart, R. M. 1941. A revision of the Strepsiptera with special reference to the species of North America. Univ. Calif. Pub. Ent., 7: 91–160.

In addition to properly mounted material it is always desirable to have a series of specimens for purposes of identification. This is particularly true with respect to the females, many of whose characters are relatively unstable. It has been the practice in the past to depend to a large extent on the identity of the host to determine the parasite. While it is true that a species of *Halictophagus* will usually confine its attack to related host species, the exceptions are so numerous as to make the application of this principle unreliable.

Holotypes and allotypes of new species herein described are deposited in the U. S. National Museum.

KEY TO THE SPECIES OF HALICTOPHAGUS IN AMERICA NORTH OF MEXICO

MALES

1. Aedeagus rounded before the apex, not sharply angular or barbed; antenna compact ..... **barberi**
   Aedeagus sharply angled before the apex, not rounded 2
2. First two antennal segments and terminal palpal segment without conspicuous, large sensoria; scutellum approaching a triangle in outline; compound eye with 30 to 40 facets visible in dorsal aspect; middle and hind tibiae not appreciably excavated externally 3
   One or both of first two antennal segments, and terminal palpal segment with conspicuous, large sensoria; compound eye with only 15 to 20 facets visible in dorsal aspect; middle and hind tibiae excavated at least a third of their length from the external apex 5
3. Front femur with a tooth-like inner basal angle ..... **insularum**
   Front femur rounded toward the inner base 4
4. Head more than four times as wide as the eye length; body about 2 mm. long to apex of postscutellum ..... **omani**
   Head less than four times as wide as the eye length; body about 1 mm. long to apex of postscutellum ..... **americanus**
5. First antennal segment, basal palpal segment, all femora, and front tibia with large sensoria; scutellum short, approaching a rectangle; flabellae of third and fourth antennal segments well separated ..... **bidentatus**
   First antennal segment, basal palpal segment, and legs without large sensoria 6
6. Front tibia with a stout, sharp basal spine; terminal segment of palpus rounded apically ..... **mackayi**
   Front tibia without a basal spine 7
7. Prescutum, scutellum and postlumbium all of about equal length; front femur with a basal angle; segments of palpus about equal in length, the terminal one with large sensoria on apical half only ..... **oncometopiae**
   Prescutum, scutellum, and postlumbium of unequal length 8
8. Scutellum approaching a rectangle, front margin almost straight; front femur with a distinct basal angle or hump; terminal palpal segment about twice as long as broad; aedeagus strongly two pronged (fig. 38), **serratus**
   Scutellum with front margin strongly convex; front femur rounded basally; terminal palpal segment about six times as long as broad, tapering to a point apically; aedeagus with only one prong (fig. 32) ..... **acutus**

MALE CEPHALOTHECAE

1. Upper margin of mouth area with a definite median lip-like area which is much thicker than the mouth rim proper 2
   Upper margin of mouth area convexly but evenly thickened toward the middle; lip-like area when present not much thicker than mouth rim proper 5
2. Upper margin of mouth area continued in a relatively smooth unbroken line to the outer edges of the mandibles ..... **mackayi**

Upper margin of mouth incomplete or at least very irregular beyond the inner edges of the mandibles....3
3. Mandible with two distinct teeth which ordinarily do not surpass the apical margin; antenna represented by a clear oval spot surrounded by a darker ring....**oncometopiae**
Mandible usually with one or more small teeth, sometimes appearing as serrations; antenna usually represented by an irregular dark spot....4
4. Maxillary area hardly half as long as clear area below mandibles....**serratus**
Maxillary area much more than half as long as clear area below mandibles, **acutus**
5. Lower margin of mouth subtending a darkly pigmented area which tapers almost to a point....**omani**
Lower margin of mouth not subtending a darkly pigmented, pointed area....6
6. With a nearly complete arched thickening over the mandibles above and separate from the upper mouth margin....**bidentatus**
Without a thickening above the upper mouth margin....7
7. Apical mandibular tooth large and sharp; upper margin of mouth area with a small but distinct anterior lip-like area....**insularum**
Apical mandibular tooth small or dull....8
8. Upper margin of mouth area without anterior thickening....**americanus**
Upper margin of mouth area with a distinct anterior lip-like projection, **serratus**

FEMALES

1. Mandible with a single tooth located at inner apex....2
Mandible with two large teeth at inner apex or with one large tooth followed by a series of smaller projections....8
2. Basal collar[2] approximating cephalothorax in size and shape or smaller; but in reverse position (see figs. 7, 8)....3
Basal collar broad and cape-like, not resembling cephalothorax in size and shape (see figs. 4, 5, 9); abdomen with three genital openings....5
3. Mandible with a hump opposing the apical tooth....**uhleri**
Mandible without a hump opposing the apical tooth....4
4. Pigmentation of thorax much darker than that of head; basal collar approximating cephalothorax in size; spiracles placed close to lateral head lobes; abdomen with three genital openings....**mackayi**
Pigmentation of thorax similar to that of head; basal collar much smaller than cephalothorax; spiracles placed far posterior to lateral head lobes; lateral thoracic margin with a distinct internal thickening midway between lateral head lobe and spiracle; abdomen with two genital openings....**callosus**
5. Basal collar less heavily pigmented than cephalothorax....6
Basal collar at least as heavily pigmented as cephalothorax....7
6. With a heavily pigmented band along the anterior margin of the brood passage opening at base of the head....**insularum**
Without a distinct heavily pigmented band along brood passage opening; mandible with a hump opposing the single large tooth....**americanus**
7. Basal collar hardly more heavily pigmented than cephalothorax; cephalothorax about as long as broad....**obtusae**
Basal collar much more heavily pigmented than cephalothorax; cephalothorax distinctly broader than long....**omani**
8. Mandibles with two large distinct teeth at inner apex....9
Mandible with a single large tooth and a series of subsidiary teeth....10
9. Basal collar nearly uniform in color and posteriorly pointed; cephalothorax distinctly longer than broad; abdomen with three genital openings, **bidentatus**
Basal collar with a dark central portion and rounded posteriorly; cephalothorax hardly longer than wide; abdomen with two genital openings, **oncometopiae**

[2]All female *Halictophagus* seen by the writer have a collar-like or cape-like pigmented area on the first abdominal sternite continuous with the cephalothorax.

10. Head with a distinct median apical lobe; mandible with a hump opposing the large apical tooth and separated from the latter by a series of small irregularities or teeth; cell-like reticulations of basal collar moderate in size; abdomen with two genital openings.....**acutus**
Head with a weakly defined median apical lobe; mandible with a series of teeth at the apex but with no opposing hump; cell-like reticulations of basal collar relatively large, some of them approaching spiracles in size; abdomen with one genital opening.....**serratus**

Halictophagus americanus Perkins

Figures 5, 26, 37

Halictophagus americanus Perkins, 1905. Hawaiian Sugar Planters' Exp. Sta. Bul. 1: 105.
Agalliaphagus americanus Pierce, 1908. Proc. Ent. Soc. Wash. 9: 80.
Agalliaphagus uhleri Pierce, 1918. Proc. U. S. Nat. Mus. 54: 479 (not *uhleri* Pierce, 1909).

This species resembles *omani* and *insularum* in many respects. It parasitizes many species of *Aceratagallia* in North America. However, a male and female studied from *Aceratagallia neosignata* Oman[3], Guitrache, Argentina, belong to an entirely different species, resembling *acutus*.

Material Studied.—Holotype female (USNM), on *Aceratagallia 4-notata* (Prov.), Columbus, Ohio; 1 female, on *A. uhleri* (Van Duzee), Rocky Ford, Colorado; 3 females, on *A. sanguinolenta* (Prov.), Scott Co. and Oregon Co., Missouri, and Peach Co., Georgia; 2 males and 2 females on *A. helveola* Oman, Garnett, Kansas; 2 females, on *A. accola* Oman, Annapolis, Maryland; 1 male and 1 female, on *A. vastitatus* Oman, Leeds, Utah; 4 females, on *A. fuscohirtus* Oman, Tuttle and Hagerman, Idaho; 2 females, on *A. californica* (Bak.), Oregon; 2 females, on *A. curta* Oman, Santa Rita Mts., Arizona; 1 female, on *Aceratagallia* species, Perris, California; 2 males, on *Eutettix tenellus* (Bak.), Mills, Utah and Berger, Idaho.

Halictophagus insularum (Pierce)

Figures 9, 24, 34

Dioxocera insularum Pierce, 1908. Proc. Ent. Soc. Wash. 9: 84.
Diozocera insularum Pierce, 1918. Proc. U. S. Nat. Mus. 54: 466.
Halictophagus insularum Bohart, 1941. Univ. Calif. Pub. Ent. 7: 148.
Diozocera insularum vincenti Pierce, 1941. Bull. So. Calif. Acad. Sci. 40: 4.
Diozocera argentinae Pierce, 1941. Bull. So. Calif. Acad. Sci. 40: 5.
Diozocera comstocki Pierce, 1941. Bull. So. Calif. Acad. Sci. 40: 6.
Diozocera comstocki elsegundinis Pierce, 1941. Bull. So. Calif. Acad. Sci. 40:10.

As recently pointed out by Pierce[4], the original description was based on an immature and imperfect male specimen mounted on its side in balsam. The uppermost antenna had lost the terminal three segments. This circumstance led Pierce in 1908 to erect a separate superfamily and family for the species. The imperfection was discovered by the writer when examining the type specimens in 1937.

---

[3]Determinations of the Nearctic and Neotropical leafhoppers mentioned in this paper were made by P. W. Oman.

[4]Pierce, W. D. 1941. A strepsipterous parasite of a leafhopper with descriptions of related species from the same host genus. Bull. So. Calif. Acad. Sci. 40: 1–10.

H. insularum appears to attack *Xerophloea viridis* (Fabr.) in various parts of the Western Hemisphere. Specimens from widely separated localities bear a close similarity. In a recent paper Pierce has described and figured a new species and subspecies on *X. viridis* (*Diozocera insularum vincenti* from St. Vincent, West Indies; *D. argentinae* from Cacarana, Argentina). At the same time he described a new species and subspecies on *X. vanduzeei* Lawson (*Diozocera comstocki* from W. Anacapa Island, California; *D. comstocki elsegundinis* from El Segundo, California). Of these, *vincenti* was described from a single female, *argentinae* from an imperfect female and a male cephalotheca, *comstocki* from two immature male pupae, and *elsegundinis* from a single imperfect female. From Pierce's illustrations and descriptions these additional names do not seem to be warranted. They are therefore tentatively placed in synonymy until more specimens are discovered.

Material Studied.—Holotype male and allotype female, Grenada, West Indies; 2 females, Salt Lake City, Utah, July 13, 1935 (P. W. Oman); 1 male and 4 females, Davis, California, Aug. 30, 1931 (H. C. Donohoe); 1 male (figs. 24, 34) Medio Agus, Province of San Juan, Argentina, Nov. 17, 1926 (C. F. Henderson); 1 female, Bahia Blanca, Argentina, Feb. 8, 1927 (C. F. Henderson).

Halictophagus omani new species

Figures 4, 16, 21, 31, 45

This species is closely related to *americanus* but can be separated by the characters given in the key. I take pleasure in naming it for P. W. Oman whose interest has made this study possible.

Male.—Antenna moderately compact, segments 3–6 with basal lengths nearly equal, first two segments with scattered small sensoria; mandible tapering gradually to a point, terminal palpal segment very slender but shorter than mandible and with inconspicuous sensoria; compound eye with about 30 facets visible in dorsal aspect; mesothoracic prescutum short and transverse, about a third as long as pronotum; metanotum as shown in figure 21; front tibia four times as long as wide at apex, with a bump near inner base; front metatarsus broad pyriform in outline; middle coxa about three-quarters as long as middle femur; second to fifth sternites with paired median pigmented spots partially fused, sixth to eighth sternites with single large median spots; aedeagus as in figure 31. Length of antenna 0.546 mm., breadth of head 0.770 mm., length of metanotum 1.246 mm.

Male Cephalotheca.—Proportions and pigmentation as in figure 45. Upper mouth margin not reaching mandibles laterally and with a slight median lip-like thickening; mandible with a large apical tooth opposed by a prominent hump. Breadth of cephalotheca 0.840 mm., height 0.574 mm.

Female.—Cephalothorax amber-colored, basal collar dark brown. Mandible with a large sharp apical tooth opposed by a moderate hump; brood passage opening with a thick lip-like margin, connected with lateral margins of cephalotherax by thickenings; basal collar cape-like, two-thirds as long as cephalothorax. Length of cephalo-

thorax 0.441 mm., length to brood passage opening 0.182 mm., breadth at spiracles 0.546 mm., breadth at base 0.483 mm.

First Larva.—Length excluding stylets 0.199 mm., stylets about two-thirds as long as rest of body.

Material Studied.—Parasites of *Oncometopia lateralis* (Fabr.): Holotype male, allotype female, and 1 male and 6 female paratypes, Howard Co., Arkansas, Sept. 27, 1937 (W. F. Turner). Other paratypes: 1 female, Athabasca River, Alberta (M. Cary); 5 females, Columbia, South Carolina, Sept. 27, 1935 (O. Cartwright); 5 females, Clemson College, South Carolina, May, 1928 (B. B. Pepper and H. G. Davis); 1 female, Jasper Co., Georgia, Sept. 2, 1936 (W. F. Turner); 1 female, Coolidge, Georgia, May 15, 1916 (W. D. Pierce); 1 female, Quincy, Florida, Oct. 27, 1905 (W. A. Hooker); 1 female, Roane Co., Tennessee, Sept. 14, 1937 (W. F. Turner); 2 males and 7 females, Hamilton Co., Tennessee, April, 1940 (W. F. Turner); 1 female, Bossier Park, Louisiana, Oct. 28, 1937 (W. F. Turner). 1 female, Tyler, Texas, May 5, 1906 (F. C. Pratt); 1 female, Denison, Texas, March 29, 1939 (L. S. Jones); 1 female, Lawrence Co., Arkansas, April 14, 1923 (B. C. Marshall); 1 female, Elkins, New Mexico, July 16, 1936 (R. H. Beamer); 1 female, Chiricahua Mts., Arizona (H. G. Hubbard); 5 females, North of Palmdale, California, June 8, 1935 (P. W. Oman); 1 female, Riverside Co., California, July, 1935. Three female metatypes, Cochise Co., Arizona, July 29, 1927 (R. H. Beamer) on *Oncometopia* species near *lateralis* (F.) Paratypes in collections of U. S. National Museum, University of Kansas, Harvard Museum of Comparative Zoology, California Academy of Sciences, and the writer.

Halictophagus obtusae new species

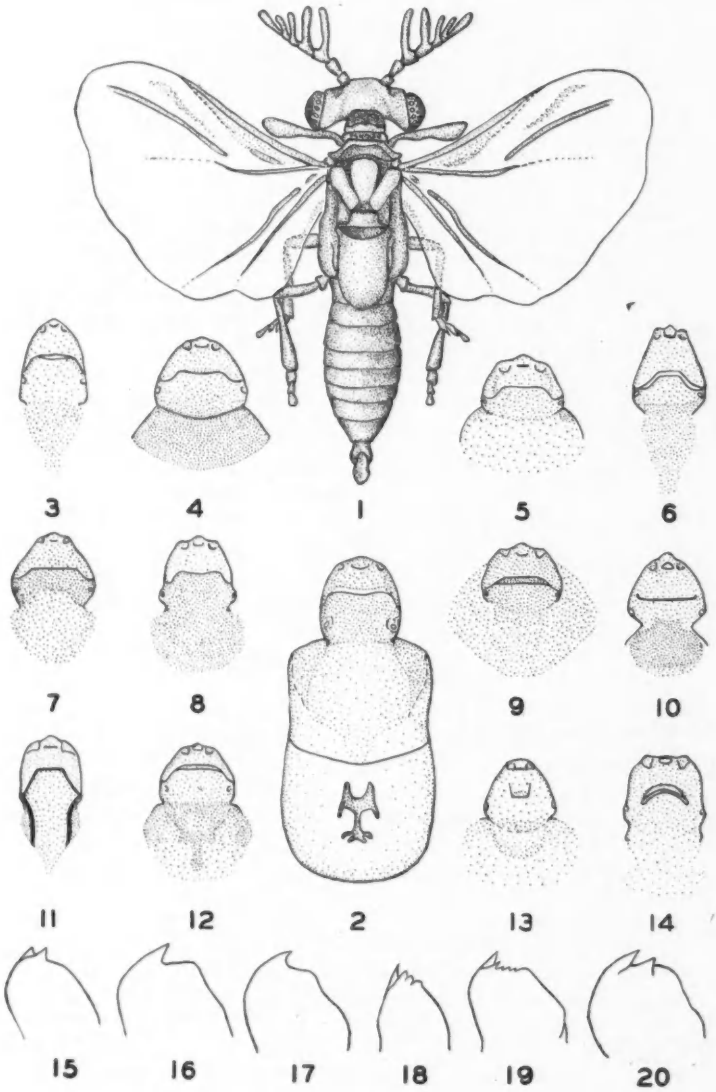
This species is similar in many respects to *americanus* and *omani*. It differs primarily in the pigmentation and greater length of the cephalothorax. It is also a larger species.

Female.—Cephalothorax amber-brown, basal collar slightly darker, especially toward the base. Mandible with a large apical tooth opposed by a moderate hump, outer margin hardly undulate; brood passage opening with a moderate lip-like thickening, connected by thickenings to lateral margins of cephalothorax; spiracles adjacent to hind margin of head; basal collar cape-like, with transverse striae, about two-thirds as long as cephalothorax. Abdomen with two genital openings. Length of cephalothorax 0.7 mm., length to brood canal opening 0.294 mm., breadth at spiracles 0.7 mm., breadth at base 0.476 mm.

EXPLANATION OF PLATE I

(Camera lucida drawings corrected for asymmetry.)

Figure 1, *Halictophagus serratus* male. 2, *serratus* female, ventral. 3–14, ventral view of female cephalothorax and basal collar. 3, *bidentatus*. 4, *omani*. 5, *americanus*. 6, *acutus*. 7, *mackayi*. 8, *uhleri*. 9, *insularum*. 10, *oncometopiae*. 11, *membraciphaga*. 12, *piperi*. 13, *chinensis*. 14, *gressitti*. 15–20, female mandible, left ventral view. 15, *bidentatus*. 16, *omani*. 17, *uhleri*. 18, *serratus*. 19, *acutus*. 20, *gressitti*.


3
4
1
5
6
7
8
9
10
11
12
2
13
14
15
16
17
18
19
20

Holotype female and 1 female paratype, Paso Ancha, San Sebastian, Costa Rica, March 11, 1936 (C. H. Ballou); on *Oncometopia obtusa* (L.). Paratype in author's collection.

Halictophagus oncometopiae (Pierce)

Figures 10, 27, 39

Dacyrtocara oncometopiae Pierce, 1918. Proc. U. S. Nat. Mus. 54: 473.
Dacyrtocara undata Pierce, 1918. Proc. U. S. Nat. Mus. 54: 474.
Halictophagus oncometopiae Bohart, 1941. Univ. Calif. Pub. Ent. 7: 150.

The holotype male in the U. S. National Museum was extracted from its puparium in a specimen of *Oncometopia undata* (Fabr.) misidentified as *O. lateralis* (Fabr.). The species described by Pierce as *Dacyrtocara undata* from *O. undata* was based on two females which undoubtedly belong to *oncometopiae*.

The species is distinctive in many ways as figured and outlined in the key. No close relationship is shown toward *omani* and *obtusae* which parasitize other species of *Oncometopia*.

Material Studied.—On *O. undata* (F.): Male puparium, Bladensburg, Maryland; male puparium, Southern Pines, North Carolina; male puparium, Meredith, South Carolina; male puparium and 5 females, Clemson College, South Carolina; holotype male (USNM), Egypt, Georgia; cotype female (USNM), Thomasville, Georgia; 1 male and an empty puparium, Hamilton Co., Tennessee; male puparium, Utica, Mississippi; 1 female, Lincoln, Mississippi; 2 females, Jackson, Alabama; 2 male puparia, Mound, Louisiana; 2 male puparia and 1 female, Opelousas, Louisiana; 2 male puparia and 1 female, Tallulah, Louisiana; 1 female, Greenville, Texas; 1 male, Siloam Springs, Arkansas; 1 female, Durant, Oklahoma. On species near *O. undata* (Fabr.): 2 male puparia and 1 female, Florida.

Halictophagus uhleri (Pierce)

Figures 8, 17

Pentagrammaphila uhleri Pierce, 1909. Bull. U. S. Nat. Mus. 66: 169 (not *Agalliaphagus uhleri* Pierce, 1918).
Halictophagus uhleri Bohart, 1941. Univ. Calif. Pub. Ent. 7: 150.

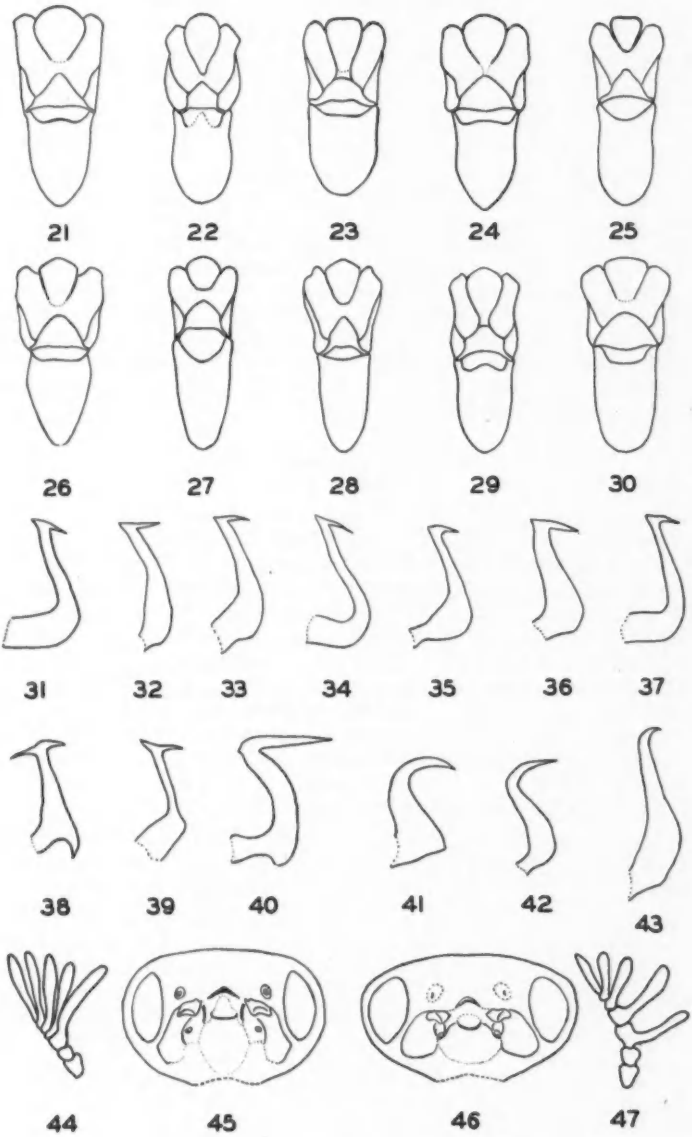
This species is known only from the female holotype at the U. S. National Museum. Although it was placed by Pierce in the family Elenchidae, it is a typical halictophagid.

Material Studied.—Holotype female on *Pentagramma vittifrons* Uhler, "Dacota."

EXPLANATION OF PLATE II

(Camera lucida drawings corrected for asymmetry.)

Figures 21–30, dorsal view of male metathorax. Figure 21, *omani*. 22, *acutus*. 23, *bidentatus*. 24, *insularum*. 25, *mackayi*. 26, *americanus*. 27, *oncometopiae*. 28, *australensis*. 29, *piperi*. 30, *membraciphaga*. 31–42, lateral view of aedeagus. 31, *omani*. 32, *acutus*. 33, *bidentatus*. 34, *insularum*. 35, *mackayi*. 36, *schwarzii* Perkins. 37, *americanus*. 38, *serratus*. 39, *oncometopiae*. 40, *piperi*. 41, *membraciphaga*. 42, *barberi*. 43, *chinensis*. 44, *piperi*, male antenna. 45, *omani*, male cephalotheca. 46, *serratus*, male cephalotheca. 47, *bidentatus*, male antenna.


21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47

Halictophagus barberi (Pierce)

Figure 42

Anthericomma barberi Pierce, 1908. Proc. Ent. Soc. Wash. 9: 84.
Halictophagus barberi Bohart, 1941. Univ. Calif. Pub. Ent. 7: 147.

The single male, without host data, on which this species was based, was redescribed and figured by Pierce (1909. Bull. U. S. Nat. Mus. 66). When the writer examined the type specimen in 1937, it had been remounted in balsam and was partially broken. It should be noted that the figure of the metanotum given by Pierce in 1909 is somewhat in error. The prescutum should be shorter and less angular, the scutellum proportionately larger and more pointed in front, and the interscutal area much more prominent. Also the antennae are more compact than is shown in Pierce's figure and an additional vein is present in the vannal area of the wing. The remounting process made it possible to study the aedeagus, which is transitional in type to that of *membraciphaga*, and entirely unlike that of any other known North American species.

Material Studied.—Holotype male (U. S. National Museum), Santa Fe, New Mexiço; host unknown.

Halictophagus mackayi (Bohart)

Figures 7, 25, 35

Pseudopatella mackayi Bohart, 1937. Pan-Pac. Ent. 13: 103 (Types, CAS).
Halictophagus mackayi Bohart, 1941. Univ. Calif. Pub. Ent. 7: 147.

The distinctively spined tibiae of the front legs of the male are a unique characteristic of this species. The heavy broad upper margin of the mouth area in the male cephalotheca was not correctly figured in the original description. It should extend to the outside of the mandibles.

Material Studied.—Five males and 15 females (type series), on *Deltocephalus* (*Ribautiella*) *affinis* G. & B., Saskatchewan, Canada (M. MacKay). According to correspondence from Margaret MacKay, other hosts of this species in Saskatchewan are *Athysanella acuticauda* (Bak.), *Laevicephalus uhleri* Oman, and *Aconura* species.

Halictophagus callosus new species

Only the female of this species is known. It is characterized by the length of the cephalothorax, the single-toothed mandibles, the peculiar callous above the spiracles, and the inconspicuous basal collar.

Female.—Cephalothorax deep amber, basal collar very pale. Cephalothorax longer than broad, front margin of head with a median lobe; mandible with a single apical tooth, broad, outer edge evenly rounded; lateral margin of cephalothorax with an internal knot-like thickening in the middle of the relatively long space between lateral head lobe and spiracle; basal collar semicircular, about half as long as cephalothorax; abdomen with two genital openings. Length of cephalothorax 0.322 mm., length to brood canal opening 0.077 mm., breadth at spiracles 0.287 mm., breadth at base 0.224 mm.

First Larva.—Length excluding stylets 0.245 mm., stylets about half as long as rest of body.

Holotype female and 2 female paratypes, Cottonwood Flats, Mt. Rainier, Washington, July 7, 1935 (P. W. Oman); 1 female paratype, Dixie, Washington, June 13, 1937 (R. M. Bohart); on *Idiocerus* species. Paratypes in collections of California Academy of Sciences and the writer.

Halictophagus bidentatus Bohart

Figures 3, 15, 23, 33, 44

Halictophagus bidentatus Bohart, 1941. Univ. Calif. Pub. Ent. 7: 147.

The antennae of *bidentatus* represent the most extreme modification yet recorded for the genus. Numerous large sensoria appear on the first two antennal segments and also on the legs.

Material Studied.—Two males and two females (including holotype and allotype in U. S. National Museum), Granger, Utah, on *Athysanella utahne* Osborne; 1 male and 3 females, Turkey Creek, Arizona, on *Flexamia flexulosa* Ball; 2 males and 6 females, Vonda, Saskatchewan, Canada, on *Euscelis frigidus* Ball, and *Deltocephalus* (*Ribautiella*) *affinis* G. and B. (host data of Canadian specimens furnished by the collector, Margaret MacKay).

Halictophagus serratus new species

Figures 1, 2, 18, 38, 46

The male of this species is especially notable for its angled scutellum and two pronged aedeagus, and the female for its distinctive mandibles and single genital opening.

Male.—General structure as in figure 1. Antenna with segments 3 and 4 unusually lengthened basally, segment 2 with about a dozen large sensoria on its ventral surface; mandible short, less than three times as long as broad, tapering to a point; terminal palpal segment about as long as mandible and pointed apically, inserted near base of first segment, covered with large sensoria; eye with about twelve facets visible dorsally; mesothoracic prescutum small, broadly U-shaped; front femur with a rounded basal angle, front tibia about five times as long as its greatest breadth; front metatarsus pyriform; middle coxa nearly as long as middle femur; hind coxa more than half as long as hind femur; second abdominal sternite with a pair of small pigmented spots, segments 3 to 7 with single small V-shaped median spots; aedeagus as in figure 38. Length of antenna 0.392 mm., breadth of head 0.448 mm., length of metanotum 0.546 mm.

Male Cephalotheca.—General proportions as in figure 46. Upper mouth margin with a small lip-like median thickening, extending in a broken line beyond mandibles; mouth area about as high as breadth of lower margin; mandible narrow, apically serrate. Breadth of cephalotheca 0.462 mm., height 0.294 mm.

Female.—Cephalothorax amber-colored, deeper along sides of head, with a pale band in front of brood canal opening, basal collar pale amber. Mandible apically serrate; metasternal area and basal collar covered with cell-like reticulations some of which approach spiracles in size; basal collar at least as large as cephalothorax and

apically pointed. Length of cephalothorax 0.182 mm., length to brood passage opening 0.084 mm., breadth at spircales 0.189 mm., breadth at base 0.161 mm.

Holotype male, allotype female, and 16 female paratypes, Princeton, New Jersey, 1940 (L. M. Black); 1 male and 1 female paratype, Hamilton Co., Tennessee, August, 1939 (W. F. Turner); 1 male paratype, Logansport, Louisiana, July 6 (W. D. Pierce); on *Agallia constricta* V. D. Paratypes in collections of U. S. National Museum, Harvard Museum of Comparative Zoology, California Academy of Sciences, and the author.

Halictophagus acutus new species

Figures 6, 19, 22, 32

This species is easily separated by the characters given in the key. Additional diagnostic characters in the male are the long basal constriction of the front and middle femora, the indented posterior margin of the postlumbium, and the narrow, hairy mandibles.

Male.—Antenna moderately compact, segments 3 and 4 slightly longer basally than those following, third segment spoonshaped, second segment abundantly supplied with large sensoria; terminal palpal segment about six times as long as broad, three times as long as first, covered with large sensoria; mandible slender, outer edge haired for two-thirds of its length; eye with about ten facets visible in dorsal aspect; mesoprescutum longer medially than pronotum; metanotum as in figure 22, postlumbium with an irregularly indented posterior margin; coxa, femur, and tibia of front leg of about equal length, front metatarsus broad ovate; front and middle femora with a long basal constriction; middle femur and tibia distinctly longer than middle coxa; apical three-quarters of middle and hind tibiae excavated externally; hind coxa about half as long as hind femur; abdominal sternites 2–7 with a pair of pigmented spots, the last five pairs broadly fused; aedeagus as in figure 32. Length of antenna 0.49 mm., breadth of head 0.546 mm., length of metanotum 0.798 mm.

Male Cephalotheca.—Upper mouth margin with a very prominent lip-like projection, extending laterally to inner edge of mandibles; mouth area distinctly higher than breadth of lower margin; mandible finely serrate apically. Breadth of cephalotheca 0.546 mm., height 0.336 mm.

Female.—Cephalothorax amber-colored, basal collar light brown. Cephalothorax longer than broad, with a distinct median apical lobe; head about as long at middle as rest of cephalothorax; mandible with a sharp apical tooth opposed by a hump, the intervening space filled with small sharp teeth; margin of brood passage opening without conspicuous thickening, connected by thickenings to sides of cephalothorax and roughly similar to it in shape. Length of cephalothorax 0.294 mm., length to brood passage opening 0.161 mm., breadth at spiracles 0.259 mm., breadth at base 0.196 mm.

First Larva.—Length excluding stylets 0.259 mm., stylets about half as long as rest of body.

Holotype male, allotype female, and 1 female paratype, Hamilton Co., Tennessee, Sept. 4, 1939 (W. F. Turner); 1 female paratype, Audubon Park, Louisiana, July 18, 1913, on sugar cane (U. C. Loftin); on *Draeculacephala mollipes* (Say). One male paratype, Atzcapolzalco, Mexico, Aug. 20, 1921, on *Draeculacephala minerva* Ball. Five female paratypes, Washington, D. C., Nov. 17, 1929 (W. H. Ball); 4 female paratypes, Adams Co., Pennsylvania, September 23, 1938 (W. F. Turner); on *Draeculacephala* species. Paratypes in collections of U. S. National Museum, California Academy of Sciences, and the writer.

ANNOTATED LIST OF THE EXOTIC SPECIES OF HALICTOPHAGUS

Halictophagus curtisii Curtis

Halictophagus curtisii Curtis, 1832. British Entomology 3: 433.

Curtis described and figured *curtisii* but ascribed the authorship to Dale who presumably had the species in manuscript. The third and fourth segments of the antennae are not as short as in many of the species of the genus, but are similar to those of *serratus*. Only the male is known. Locality, England; host unknown.

Halictophagus cladoceras (Jeannel)

Tettigoxenos cladoceras Jeannel, 1913. Voyage de Ch. Alluad et R. Jeannel en Afrique Orientale. Insects Strepsipteres, pp. 1–8.

From Jeannel's description the antennae are of the compact type, the aedeagus is slender with barbed apex, the prescutum is triangular, and the scutellum is transverse pentagonal. Only the male is described.

Locality, British East Africa; host unknown.

Halictophagus australensis Perkins

Figure 28

Halictophagus australensis Perkins, 1905. Hawaiian Sugar Planters' Assn. Exp. Sta. Bull. 1: 103.
Pentoxera australensis Pierce, 1908. Proc. Ent. Soc. Wash. 9: 81.
Pentozocera australensis Pierce, 1918. Proc. U. S. Nat. Mus. 54: 474.

Figures of both sexes were given by Perkins. The male antennae are greatly compressed. The original drawing of the metanotum is from the holotype specimen in the U. S. National Museum.

Locality, Australia (Queensland); host, *Tettigonia parthaon* Kirkaldy.

Halictophagus phaeodes Perkins

Halictophagus phaeodes Perkins, 1905. Hawaiian Sugar Planters' Assn. Exp. Sta. Bull. 1: 103.
Pentoxocera phaeodes Pierce, 1908. Proc. Ent. Soc. Wash. 9: 81.
Pentozocera phaeodes Pierce, 1918. Proc. U. S. Nat. Mus. 54: 495.

Diagrammatic sketches of the female only of this and the following species were given by Perkins. The holotypes of both species in the host specimens are in the U. S. National Museum.

Locality, Australia (Queensland); host, *Hecalus immaculatus* Kirkaldy.

Halictophagus stenodes Perkins

Halictophagus stenodes Perkins, 1905. Hawaiian Sugar Planters' Assn. Exp. Sta. Bull. 1: 104.
Pentoxocera stenodes Pierce, 1908. Proc. Ent. Soc. Wash. 9: 81.
Pentozocera stenodes Pierce, 1918. Proc. U. S. Nat. Mus. 54: 475.

Locality, Australia (Queensland); host, *Paradorydium menalus* Kirkaldy.

Halictophagus schwarzii Perkins

Figure 36

Halictophagus ? schwarzii Perkins, 1905. Hawaiian Sugar Planters' Assn. Exp. Sta. Bul. 1: 104.
Pentacladocera schwarzi Pierce, 1908. Proc. Ent. Soc. Wash. 9: 80.

Only the male of this species is described and figured by Perkins. The antennae are compact but less so than in *australensis*. The terminal palpal segment is also much longer and more slender than in the latter species. The figure of the aedeagus is from the holotype in the U. S. National Museum.

Locality, Australia (New South Wales); host, *Agallia* species.

Halictophagus (?) **tryoni** (Perkins)

Megalechthrus tryoni Perkins, 1905. Hawaiian Sugar Planters' Assn. Exp. Sta. Bul. 1: 106.

Until the male of this species is located it is not certain whether it belongs to *Halictophagus* or *Stenocranophilus*. If it should turn out to be the latter, the name *Megalechthrus* would have priority. Two paratype females are in the U. S. National Museum.

Locality, Australia (Queensland); host, *Platybrachys* species.

Halictophagus paradeniya (Pierce)

Pentozoe paradeniya Pierce, 1911. Proc. U. S. Nat. Mus. 40: 505.

Both sexes were described by Pierce. Only the male holotype at the U. S. National Museum has been seen by the writer. The antennae are of the compact type, and the terminal palpal segment is long and tapering. A dorsal view of the male is figured by Pierce (Proc. U. S. Nat. Mus. 54, plate 75).

Locality, Ceylon (Paradeniya); host, *Thompsoniella arcuata* Mots.

Halictophagus jacobsoni Meijeire

Halictophagus jacobsoni Meijeire, 1908. Tijd. Ent. 51: 186.
Neocholax jacobsoni Pierce, 1909. Bull. U. S. Nat. Mus. 66: 161.

From the figures given by Meijeire, the male antennae are of the compact type but with the third and fourth segments longer than in *paradeniya*. The aedeagus is angularly hooked at the apex, the terminal palpal segment is long and tapering, and the female cephalothorax is nearly round in outline.

Locality, Java; host, *Ossoides lineatus* Bierman.

Halictophagus javanensis (Pierce)

Cyrtacaraxenos javanensis Pierce, 1918. Proc. U. S. Nat. Mus. 54: 475.

Figures of the unique holotype male in the U. S. National Museum are given by Pierce. The antennae are greatly compressed at the bases of the segments. The terminal palpal segment is very small; the eyes have unusually large facets; and the aedeagus is slender and sharply barbed at the apex.

Locality, Java (Buitenzorg), at light.

Halictophagus (?) **insidiator** (Westwood)

Colacina insidiator Westwood, 1877. Trans. Ent. Soc. Lond., p. 185.

The original description was based by Westwood on characters of the male cephalotheca. Until more material is found, the systematic position of the species is questionable.

Locality, Borneo (Sarawak); host, *Epora subtilis* Walker.

Halictophagus fulmeki (Hofeneder)

Oedicystis fulmeki Hofeneder, 1927. Treubia 9: 377.

The single male specimen described and figured by Hofeneder is remarkably similar to, if not the same as, ***membraciphaga***. The close relationship is particularly indicated by the aedeagus, which appears to match that of ***membraciphaga*** exactly. The antennae are compact and the terminal palpal segment is small.

Locality, Sumatra, at light.

Halictophagus membraciphaga (Subramaniam)

Figures 11, 30, 41

Indoxenos membraciphaga Subramaniam, 1927. Trans. Ent. Soc. Lond. 75: 132.

The figures were drawn from a long series of topotype specimens sent to the author by T. V. Subramaniam. The antennae are of a moderately compressed type. The female cephalothorax projects onto the abdomen in a long triangle and the female mandible has two distinct teeth.

Locality, India (Mysore State); host, *Otinotus pallescens* Distant.

Halictophagus compactus (Pierce)

Pyrilloxenos compactus Pierce, 1914. Proc. Ent. Soc. Wash. 16: 129.

The specific name is derived from the compact antennae. Both sexes are described and the characters of the male are figured by Pierce. The aedeagus is apically hooked and basally inflated. The terminal palpal segment is long and tapering as in *schwarzii*, *jacobsoni* and *paradeniya*. The writer examined three female cotypes at the U. S. National Museum. The cephalothorax is short and apically truncate. The mandibles are set just in front of the brood canal margin and at such an angle that they point almost directly toward each other.

The distribution and life cycle of this species have been recently discussed by K. A. Rahman (1941. Ind. Jour. Agr. Sci. 11 : 119–128).

He states that the parasite is often abundant in the sugarcane areas of Punjab and that it has five generations a year.

Locality, India (Bihar); hosts, *Pyrilla aberrans* Kirby and *P. perpusilla* Walker.

Halictophagus indicus new species

Pyrilloxenos compactus Subramaniam, 1922. Bull. Ent. Res. 12: 465.

T. V. Subramaniam (above citation) described and figured a halictophagid parasitizing mango jassids in India. He tentatively called it *Pyrilloxenos compactus* Pierce, but indicated that it was possibly different from that species. An examination of a series of specimens sent the writer by Subramaniam proves it to be a new species. *H. indicus* is the first known species of the genus to have four genital tubes in the female. The female mandibles are strongly bidentate with the teeth often well separated as in *gressitti* (fig. 20). It differs from the latter in the character of the basal collar and in the structure of the brood canal opening. It can be separated from *membraciphaga* by the more arcuate brood canal opening and the lateral collar thickenings of the latter. The other Indian species, *compactus*, has a shorter female cephalothorax which has the mandibles pointing toward each other and only one-toothed.

Male.—(Dorsal view figured by Subramaniam, 1922. Bull. Ent. Res. 12, plate 15, fig. 1). Antenna compact, segments 3 and 4 slightly longer basally than those following; terminal palpal segment long and cylindrical; eyes with very large and relatively few facets. (Description drawn from immature specimens.)

Male Cephalotheca.—Mandible squarish, with two prominent teeth separated by a deep cleft; upper margin of mouth area with a distinct median lip-like projection; mouth area slightly higher than breadth of lower margin which subtends a semicircular pigmented area. Breadth of cephalotheca 0.497 mm., height 0.336 mm.

Female.—Cephalothorax deep amber, darker on thorax; basal collar dark brown. Head with a moderate, broad apical lobe; inner apex of mandible with two large teeth separated by a deep cleft; brood passage opening almost straight in the middle, sloping at a 45-degree angle laterally where it is connected with lateral margins of cephalothorax by thickenings just above spiracles; cephalothorax widest opposite brood passage opening; basal collar somewhat shorter than cephalothorax, constricted subapically, bluntly pointed (shape of collar similar to that shown in figure 3). Length of cephalothorax 0.266 mm., length to brood passage opening 0.119 mm., breadth at spiracles 0.238 mm., breadth at base 0.196 mm.

Holotype female, and 9 female paratypes, Mysore State, India (T. V. Subramaniam), on *Idiocerus niveosparsus* Leth. (It is also reported by Subramaniam on *Idiocerus atkinsoni* Leth. and *I. clypealis* Leth. from Mango in Mysore State). Paratypes in collections of California Academy of Sciences and the writer.

Halictophagus gressitti new species

Figures 14, 20

The "squarish" female cephalothorax and the two toothed mandibles easily distinguish this species from all others thus far described in the genus.

Female.—Cephalothorax and a short strip on basal collar deep amber, remainder of basal collar very pale amber. Head not projecting in front of mouth, mandible with two well separated strong teeth and an undulate outer margin; brood passage opening not connected with lateral edge of cephalothorax, and with a prominent lip-like margin; base of cephalothorax broad; basal collar roughly square, slightly longer than cephalothorax. Length of cephalothorax 0.490 mm., length from apex to brood canal opening 0.322 mm., breadth at spiracles 0.539 mm., breadth at base 0.434 mm.

Male Cephalotheca.—Mandible with two long teeth opposed by a high narrow hump and followed by a second hump near outer base; upper mouth margin without a distinct lip, not surpassing mandibles laterally; mouth area about one and two-fifths as high as width of lower margin. Breadth of cephalotheca 0.98 mm., height 0.56 mm.

Holotype female, 1 female paratype, and male cephalotheca, Liamui, Hainan Island, China, Aug. 2, 1935 (L. Gressitt); 1 female paratype, and male cephalotheca, Nodoa, Hainan Island, China, June 28, 1935 (L. Gressitt); on *Tituria chinensis* Distant (E. P. Van Duzee det.). Paratypes in collections of California Academy of Sciences and the writer.

Halictophagus chinensis new species

Figures 13, 43

The peculiar structure of the brood canal opening of the female and the long curved male aedeagus are distinctive. Also, the only two other species thus far described from the Far East, *gressitti* and *orientalis*, both have strongly bidentate female mandibles.

Male.[5]—Antenna of moderately compact type, segments 3 and 4 longer basally than segments 5–7, prolongation of segment 5 shorter than that of either 4 or 6, first two segments without large sensoria; terminal palpal segment long and slender, without large sensoria; mandible with parallel sides except at apex; legs long and very slender, middle coxa longer than middle femur, first tarsal segment broadly oval; aedeagus as in figure 43.

Male Cephalotheca.—Antennal ring adjacent to mandible; upper mouth margin thick lip-like, reaching mandibles laterally; mandible with weak apical tooth; mouth area about one and a third times as high as breadth of lower mouth margin. Breadth of cephalotheca 0.854 mm., height 0.7 mm.

Female.—Cephalothorax amber-colored, basal collar very pale amber with a darker ring (fig. 13); mandible with a single tooth opposed by a prominent hump; brood passage opening narrow and

[5]The description of the male is drawn from a fragmentary specimen partially destroyed by fungous, extracted from its puparium.

connected with thickenings to inner base of mandibles rather than with lateral edges of cephalothorax, opening with a distinct lip-like margin; basal collar broadly cape-like, as long as cephalothorax; abdomen with two genital openings. Length of cephalothorax 0.672 mm., length to brood canal opening 0.378 mm., breadth at spiracles 0.742 mm., breadth at base 0.588 mm.

First Larva.—Length of body excluding stylets 0.203 mm. Stylets about half as long as rest of body.

Holotype female, allotype male, and 1 female paratype, Tai Au Hong, S. Kiangsi Province, China, July 7, 1936 (L. Gressitt); 3 female paratypes, Yim Na Sen, E. Kwantung Province, June 13, 1936 (L. Gressitt); on *Cicadella ferruginea* Fabr. Paratypes in collections of California Academy of Sciences and the writer.

Halictophagus piperi new species

Figs. 12, 29, 40

The distinctive structure of the basal collar in the female and the aedeagus in the male separate this species. It is the first leafhopper parasite to be described from the Philippines.

Male.—Antenna compact, segments 3–7 nearly equal in basal length and with long flabellae, first two segments with a few small scattered sensoria; terminal palpal segment a little longer than basal segment, tapering apically, without large sensoria; mandible triangular, about as long as basal palpal segment; eye with not more than twelve facets visible in dorsal apsect and about seven visible in ventral aspect; prescutum of mesothorax unusually large and shield-like, twice as long as pronotum; metanotum as in figure 29; front leg relatively short and stout, tibia twice as long as thick at apex, first tarsal segment broadly oval; middle and hind legs long and slender, middle coxa longer than middle femur; abdominal sternites with two rows of pigmented spots, the last five pairs fused in the middle; aedeagus as in figure 40. Body about 4 mm. long, length of antenna 0.73 mm., length of metanotum 1.44 mm., breadth of head 0.87 mm.

Male Cephalotheca.—Antennal ring separated by its radius from mandible; upper mouth margin with a moderate median thickening; mouth area about as high as breadth of lower margin; mandible with two weak apical teeth followed by a fairly sharp angle at outer summit. Breadth of cephalotheca 0.952 mm., height 0.574 mm.

Female.—Cephalothorax light brown, darker at sides and base; anterior half of basal collar, except for a dark ring, slightly paler than cephalothorax, posterior half very pale (fig. 12). Mandible with two large apical teeth (inner tooth hidden behind outer in some paratypes) opposed by a moderate hump; brood passage opening broad, connected with lateral edges of cephalothorax by thickenings, opening bounded by a simple thickening, not lip-like; basal collar cape-like with a distinctive necklace-like dark median band which is pointed posteriorly and undulate laterally. Length of cephalothorax 0.581 mm., length to brood canal opening 0.182 mm., breadth at spiracles 0.630 mm., breadth at base 0.511 mm.

First Larva.—Length of body excluding stylets 0.238 mm., stylets about two-thirds as long as rest of body.

Holotype male and 1 female paratype, Lamao, Luzon, Philippine Islands, March 6, 1911 (C. V. Piper); female allotype and 2 female paratypes, Rizal, Luzon, Philippine Islands, March, 1930 (A. Duyag); on *Cicadella longa* Wall (Merino det.). Paratypes in collections of California Academy of Sciences and the author.

Halictophagus orientalis (Esaki and Hashimoto)

Tettigoxenos orientalis Esaki and Hashimoto, 1931. Pub. Ent. Lab. Kyushu Imp. Univ. 2.

The species is figured in the "Iconographia Insectorum Japanicorum," first edition, 1932. Apparently the male has compact type antennae and a metathorax similar to that figured for ***bidentatus*** (fig. 23) but with the scutellum proportionately somewhat longer. The female mandibles are figured as strongly bidentate.

Locality, Japan; host, a species of rice leafhopper.

Halictophagus (?) **schwarzi** (Pierce)

Pentoxocera schwarzi Pierce, 1909. Bull. U. S. Nat. Mus. 66: 159.
Pentozocera schwarzi Pierce, 1918. Proc. U. S. Nat. Mus. 54: 475.

This species was based on a single male cephalotheca. Until the mature forms are known the relationships are in doubt. If the species should prove to be a true *Halictophagus* the specific name would have to be changed (see *H. schwarzii* Perkins, 1905; p. 354).

Locality, Guatemala (Cacao); host, *Diedrocephala sanguinolenta* Coquibar.

SHELTER TREES IN WAR AND PEACE, by EPHRAIM PORTER FELT. Pages 1–320, 6 x 8½ inches, 53 illustrations. Published by ORANGE JUDD PUBLISHING COMPANY, INC., New York. 1943. Price, $2.50.

In these days of the increasing use of aerial attack in warfare, people are becoming more and more aware of the value of trees as a means of concealment. This book deals primarily with the problem of utilizing trees for their protective concealment value, and the importance of a wise tree policy for immediate as well as future needs. Many trees have been destroyed or injured as a result of the hasty establishment of military and industrial projects; these trees may be saved by early treatment more easily than they can be replaced.

The introductory chapters of the book deal with the general relation of trees to human welfare, and the problem of shelter. The main body of the book deals with the structure and growth of trees, the prevention or correction of tree troubles, the problem of selecting shelter trees, the various types of shelter trees, and shelter tree policies.

The book is clearly written and well illustrated. It is an important and timely book in that it presents a situation that has a direct bearing on our war effort. It will be of interest to entomologists because it points out a way in which they can further the war effort—by helping to conserve trees for their shelter value.

—D. J. B.

THE PRIMARY LARVA AND SYSTEMATIC POSITION OF THE MELOID GENUS POREOSPASTA

(Coleoptera)

J. W. MacSWAIN,[1]
University of California

Leach (1815) was the first to divide the family Meloidae of present day authors into groups. Two of the three major categories which he established were the Meloinae (Meloidae) and the Lyttinae (Cantharidae). Most authors have recognized these two groups, although various names and levels of classification have been applied to them. LeConte and Horn (1883) in their classification of the Coleoptera placed the genus *Poreospasta* in the Meloinae (Meloini). Wellman (1910) accepted the assignment of *Poreospasta* to this group, and placed the genus in one of four subgroups, the Apterospastides. Subsequent authors followed LeConte and Horn, and Wellman, in this respect until Van Dyke (1928) showed that the genus *Poreospasta* was closely related to *Lytta* on the basis of adult characters. He assigned the genus a position intermediate between *Lytta* and *Meloe* and because of this, suppressed the Lyttinae (Lyttini) within the Meloinae (Meloini). Böving and Craighead (1931), using larval characters, have shown that the Lyttinae and Meloinae are amply distinct and of more or less equal value with the subfamilies Zonitinae (Nemognathinae) and Horiinae. The primary larva of *Poreospasta* confirms the conclusion expressed by Van Dyke as to the close relationship of *Lytta* and *Poreospasta*, but it shows no similarity to *Meloe* nor does it exhibit any intermediate characters that invalidate the separation of the Meloinae and Lyttinae as two of the primary divisions of the family Meloidae.

The genus *Poreospasta* is represented by two species, *P. polita* Horn and *P. sublaevis* (Horn), both of which are restricted to California, where they are found in the dryer parts of the San Joaquin Valley, the hills which bound it on the west, and the Mojave desert in the south. Only primary larvae of *polita* were obtained for this study and the description below was based on that species. *Meloe strigulosus* Mann. was selected as representative of the genus *Meloe* although fifteen other domestic and European species were available for comparative study, and *Lytta magister* Lec. was utilized because of the similarity between the larva of that species and *Lytta vesicatoria* L.

---

[1]The author is indebted to Dr. E. G. Linsley for many helpful suggestions and assistance in the course of this study.

DESCRIPTION OF FIRST INSTAR LARVA OF POREOSPASTA

Body form elongate, slender, subparallel-sided. Length 3.1 mm. to 3.5 mm., greatest abdominal width .5 mm. Color light brown to sepia brown, membranous areas pale yellowish brown to white. Setae few, forming a definite pattern on head, thorax, and abdomen. Ninth abdominal segment with two pairs of macrochaetae, the median pair three and one-half times as long as the outer pair.

Head large, subquadrate, as broad as mesothorax, broadly joined to prothorax. Labrum broad, transverse, with one third total head width, one fourth as long as broad, exerted, covering most of mandibles when closed, anterior margin with a double row of setae; posteriorly separated from clypeus by a well defined clypeo-labral suture. Clypeus complete, narrow, arcuate, laterally bounded by anterior median margins of antennal foramina. Fronto-clypeal suture weakly defined, separating clypeus and frons, marked by a single row of setae on posterior margin of clypeus. Frons well developed, defined anteriorly by the fronto-clypeal suture, laterally by the antennal bases and posteriorly by the lateral arms of the (epicranial) suture. Epicranial suture well defined, attaining posterior margin of head, anterior arms attaining antennal foramina. Epicranial halves with a definite pattern of dorsal setae and three pairs of ventral lateral setae directly below ocelli. Ocelli a single pair, equal in diameter to sensory appendices of second antennal segment in anterior one third of epicranial halves about two thirds of the distance from the epicranial suture to lateral margin of head. Antennal foramen large, anteriorly contiguous with the mandibular foramen. Antennae three-segmented, exclusive of terminal macrochaeta about twice as long as broad, first two segments subequal in width, broader than long, the second segment with a sensory appendix on the ventral lateral apex, the third segment laterally articulated with the second, about two and one-half times as long as broad, terminal macrochaeta over three times as long as segment, several shorter setae on second and third segments and (sensory) pits on segments one and two. Mandibles subangularly arcuate, as long as from posterior margin of head to posterior margin of antennal foramen, basically enlarged, apical half sharply attenuate, condyle on outer third of posterior margin. Maxillae well developed, weakly sclerotized, equal in length to mandible; cardo broad, short, about one-third length of stipes; cardo and stipes forming a broad flat plate about twice as long as broad, slightly attenuate posteriorly; stipes with two long median setae, numerous setae on anterior inner margin; maxillary palpi three-segmented, equal in length to width of labrum, surpassing anterior margin of labrum, first two segments each broader than long, subequal; third segment equal in length to first two segments, with numerous small setae on apex. Labium well defined, weakly sclerotized, about as long as broad, anteriorly attaining an imaginary median line transverse across labrum; labial palpi two-segmented, twice as long as mentum, second segment of palpi twice as long as first and one half as broad as maxillary palpi; mentum

subquadrate, with two long median setae and two short setae on posterior margin; submentum broad, flat, twice as long as mentum, posteriorly attenuate. Gula narrow, parallel-sided, about four times as long as broad.

Thorax one half as long as abdomen, segments with a definite pattern of long tergal setae, a few small setae on dorsal and lateral membranous areas and sternites. Prothorax slightly wider and shorter than head, postero-lateral angles broadly rounded; pronotal shield rectangular, covering almost entire tergum; medio-dorsal suture fully developed, extending the entire length of the tergal plate; sternal elements not as strongly chitinized as notum. Meso- and metathorax decreasing in size, smaller than prothorax and with smaller tergal plates. Mesothoracic spiracle moderately large, on antero-lateral margin of tergal plate. Legs elongate, slender, increasing in length; coxae robust, about two thirds as long as prothoracic tergal plate, twice as long as broad, several long setae on distal one third of segment; articulated to a dorsal pleural plate, plates triangular, decreasing in size on meso- and metathorax; trochanters small, weakly sclerotized, about one fifth as long as coxae, as long as broad; femora slightly longer than coxae, one-fourth as broad as long, base of segment moderately broad, narrowed to apex, surface with three rows of short setae; tarsi one third as long as tibiae, tapering, apex curved, major seta nearly attaining apex, minor seta one third as long as major seta.

Abdomen with first tergite completely divided by a median suture continuous with those of the thorax; spiracle of first tergite slightly smaller than mesothoracic spiracle, spiracles on first to eighth tergites laterally placed, medially about three fourths of the distance from the median line to lateral margin of segment, spiracle of eighth tergite one half the diameter of mesothoracic spiracle; segments increasing in width from first to fifth, decreasing from fifth to ninth, first tergite about three times as broad as long, fifth tergite about four times as broad as long, about one and one fourth times as broad as first tergite, ninth segment subquadrate, slightly longer than broad, a single row of setae along posterior margins of the abdominal tergites, about as long as the tergites, small regularly placed setae and (sensory) pits in median portion of plates. No visible sternites.

On the basis of the primary larva, *Poreospasta* may be placed in the subfamily *Lyttinae* by the following combination of characters: head subquadrate, labrum, clypeus and frons not fused, antennae with a

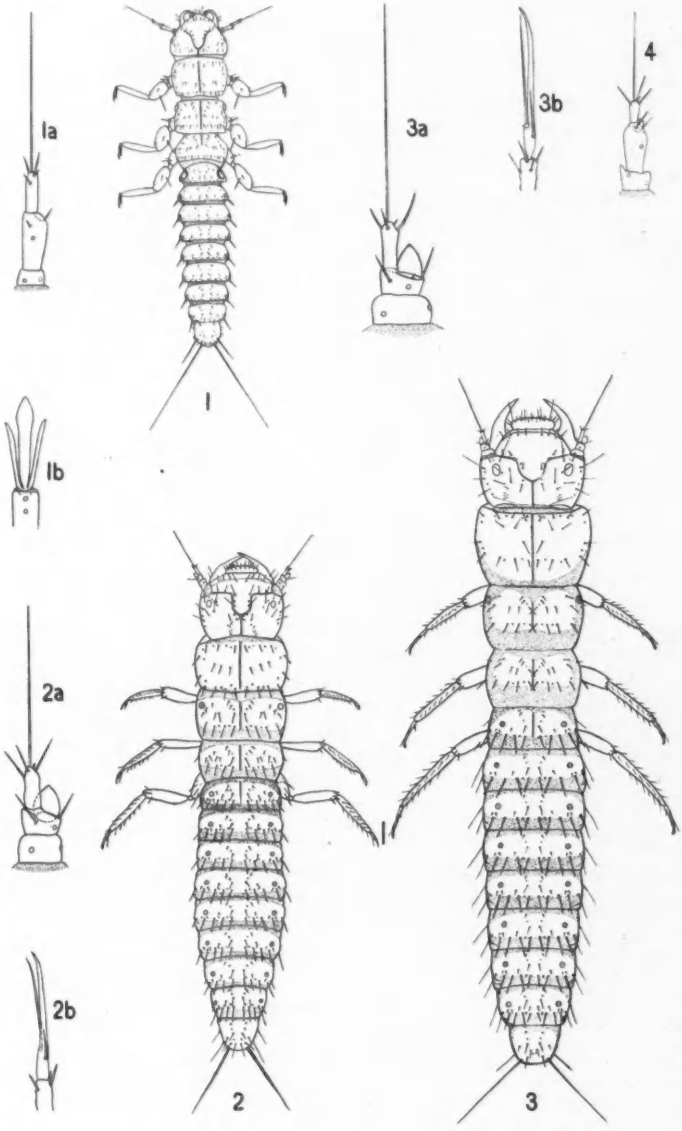
---

EXPLANATION OF PLATE

Fig. 1. *Meloe strigulosus* Mann., first instar larva, dorsal view, × 22. 1a. *M. strigulosus* Mann., antenna, dorsal view, × 125. 1b. *M. strigulosus* Mann., tarsus, dorsal view, × 125. 2. *Poreospasta polita* Horn, first instar larva, dorsal view, × 22. 2a. *P. polita*, antenna, dorsal view, × 125. 2b. *P. polita* Horn, tarsus, lateral view, × 125. 3. *Lytta magister* Lec., first instar larva, dorsal view, × 22. 3a. *L. magister* Lec., antenna, dorsal view, × 125. 3b. *L. magister* Lec., tarsus, lateral view, × 125. 4. *Epicauta puncticollis* (Mann.), antenna, dorsal view, × 125.

Primary Larva of Poreospasta
J. W. Macswain

PLATE I



large sensory appendix on the lateral apex of the second segment, ocelli reduced to a single pair, abdominal spiracles uniform in size and position, and ventral integument thin.

Unfortunately the inadequate number of primary larvae of *Lytta* available for study make it impractical to distinguish the genera *Lytta* and *Poreospasta* generically. *Poreospasta polita* may be separated from *Lytta magister* on the basis of the following characters: sensory appendix of the second antennal segment equal in size to the ocellus rather than subequal, third segment of the maxillary palpus equal in length to the first two segments rather than shorter than these segments, antennal foramen larger than first antennal segment rather than smaller, and (lateral arms of) epicranial suture attaining the antennal foramen rather than falling short of the antennal foramen. Both *Poreospasta* and *Lytta* may be readily separated from the other members of the subfamily which have been described by the short second antennal segment with the large sensory appendix on the lateral apex (compare with *Epicauta*, (fig. 4), and *Macrobasis*).

SELECTED BIBLIOGRAPHY

Böving, A. G., and **Craighead, F. C.** 1931. An illustrated synopsis of the principal larval forms of the order Coleoptera. Entom. Amer., 11: 1–351, pls. 1–125.

Cockerell, T. D. A. 1910. The classification of the Meloidae. Ent. News, 21: 307.

Hachfeld, G. 1931. Über die Primärlarve der *Meloë brevicolis* Panz. und über die bis jetzt bakannten primärlarven deutscher Meloiden. Zeitz. für Wiss. Insekten Biol., 26: 42–47, 3 figs.

Horn, G. H. 1868. New species of Coleoptera from the Pacific district of the United States. Trans. Am. Entom. Soc., 2: 129–140.

Leach, W. E. 1815. Edinburgh Encyclopedia.

LeConte, J. L., and **Horn, G. H.** 1883. Classification of the Coleoptera of North America. Smithson. Misc. Coll., 26: i-xxxviii, 1–567.

Parker, J. B., and **Böving, A. G.** 1924. The blister beetle *Tricrania sanguinipennis*—Biology, descriptions of different stages, and systematic relationships. Proc. U. S. Nat. Mus., 64, No. 2513, Art. 23, pp. 1–40, pls. 1–5.

Van Dyke, E. C. 1928. A reclassification of the genera of North American Meloidae, and a revision of the genera and species formerly placed in the tribe Meloini, found in America north of Mexico, together with descriptions of new species. Univ. of Calif. Publ. Ent., 4: 395–494, pls. 15–19.

Wellman, F. C. 1910. On the classification of the Lyttidae (Meloidae s. Cantharidae Auctt.), Entom. News, 21: 211–222.

A MANUAL OF EXPERIMENTAL EMBRYOLOGY, by VIKTOR HAMBURGER. Pages xvii and 213, 142 figs. 1942. Cloth, octavo. Published by THE UNIVERSITY OF CHICAGO PRESS. Price, $2.50.

Among recent purchases of books for our own library is one we wish to call to the attention of those interested in insect embryology. It gives detailed instructions for experimental work on vertebrate eggs. While the usual insect egg is so condensed and has such a hard yolk that experimental work becomes very difficult we ever hope that more attempts will be made to do such work. The clear outline given by Hamburger may suggest parallel operations that could be used on insect eggs.

The subjects treated in detail are: Part I. Equipment; II. Experiments on Amphibian Embryos; III. Experiments on the Chicken Embryo; IV. Regeneration; V. The Gradient Theory. And: Appendix: Plan for a One Semester Course. Index.—C. H. K.

STUDIES IN NEOTROPICAL STRATIOMYIDAE
(Diptera)

V. The Classification of the Rhaphiocerinae

MAURICE T. JAMES,
Colorado State College,
Ft. Collins, Colorado

The position of the several genera of Stratiomyidae treated in this paper has been a subject of considerable disagreement. Macquart (1834, 1838) laid the foundation for the classification of this subfamily when he described *Hoplistes*, *Dicranophora*, *Rhaphiocera* and *Basentidema*; and, although these genera did not come together in his outline classification, they were numbered consecutively (16 to 19 respectively) and followed each other in the text. Loew (1855) proposed the name *Analcocerus* and considered this genus, together with the four of Macquart, in his discussion of the "Sargus-Arten." Schiner (1868) proposed the generic name *Histiodroma* for *Sargus inermis* Wied., and the subfamily name *Rhaphiocerinae* in essentially the same sense in which it is used in the present paper.

Subsequent attempts to determine relationships in this group have been less successful, mainly because of the emphasis placed upon antennal structure in the systems of classification. At first sight, the aristate type of antenna found in *Rhaphiocera* and the elongated, eight-segmented type of *Analcocerus* appear quite different. If this differentiation is an ancient one, the similarity in appearance in other respects may be considered the result of divergence. To me, this viewpoint is highly objectionable, since, in the first place, there are several cases of exactly parallel "divergence" in the Stratiomyidae, and, in the second, there are cases of gradual transition from one type to another. This subject will be discussed more completely in another paper.

Among more recent dispositions of these genera and attempts to define the genera themselves we might mention those of Brauer (1882), Williston (1888 and 1900), Kertész (1908), Enderlein (1914) and Lindner (1931). Brauer, though placing *Analcocerus*, *Rhaphiocera*, etc. in the "Sargidae," was impressed by the difference in antennal structure to such an extent as to associate *Analcocerus* with *Campeprosopa*, *Eudmeta*, and *Acrochaeta* in a separate division. Kertész has transferred the above group to the Hermetiinae, whereas Williston states that *Analcocerus* (also *Campeprosopa*, which, however, he misunderstood) "clearly belong to the Sarginae." Enderlein has proposed for *Analcocerus* a new subfamily name, Analcocerinae.

The antennal evolution of this group appears to be approximately as follows. In all members, the antennae have been reduced to eight segments, segment eight, according to Enderlein's interpretation, representing numbers eight to ten of the primitive Stratiomyid antenna.

Then segments three to five (the first three of the flagellum) become shortened and compact, (as in *Euparyphus, Adoxomyia,* and other genera showing a tendency toward arista formation); the other segments, especially the last one, become more elongated. This transition is made from *Neanalcocerus* to *Analcocerus.* The basal three segments of the flagellum having already become short and compact, the apical three now become lengthened and thinned out into an arista which is at first terminal (e. g. in *Rhaphiocera*), but later migrates dorsad of the fifth antennal segment (e. g. in *Basentidema*). Thus the three divisions, as recognized by Enderlein (no arista, dorsal arista, terminal arista) can be maintained, if their phylogenetic relationship is recognized.

The subfamily as here outlined will be more difficult to define than that of the Brauer-Kertész-Enderlein classification; but I believe it is more nearly natural. All members are more or less elongated, slender flies, with inconspicuous pile, and usually black with conspicuously yellow or green markings which conform to surprisingly similar patterns. The antennae are eight-segmented, though the last three may form an arista and the three preceding ones are usually compact and closely united, though with distinct annulations; the antennae are longer than the head. The eyes are broadly separated in both sexes, and in all known species are bare. The mouth parts are well developed. The thorax is usually narrow in front and widens to a maximum at the wing bases. The scutellum is two-spined, although often the spines are reduced or lost. The wings tend toward unusual forms and venation, such as a thickening or even a great expansion of the costa; a truncation of the upper apical angle, the assumption of a triangular form through the weakening of the anal angle, the weakening of the base of vein R_s and the fracturing of R_1 (sometimes also the costa) near the origin of R_s, etc. Wing veins are strong; cross veins r-m and m-cu are present and usually long; the media is three branched, and the branches are long and strong; there are five posterior and usually two submarginal cells; vein R_5 is frequently bent downward at its point of separation from R_4. The abdomen is slender and as long or longer, but usually no wider, than the thorax. The legs are relatively long, sometimes with modifications.

So far as known, the subfamily is strictly Neotropical. The Palaearctic genus *Rhaphiocerina* certainly does not belong here, but probably instead to the Stratiomyinae, along with *Nothomyia.*

KEY TO THE GENERA OF RHAPHIOCERINAE

1. Antennae elongated, the flagellum eight-segmented, without an arista.....2
   Antennae shortened, the flagellum with a well-defined arista, the annulated part usually not much longer than the second segment.....3
2. Last segment of flagellum two or three times as long as preceding one; basal three segments of flagellum very short; costa may be thickened at stigma, but not beyond; stigma relatively long. R_{2+3} arising at a considerable distance beyond cross vein r-m (p. 367).....**Analcocerus**
   Last segment of flagellum barely longer than preceding one; basal segments of flagellum not greatly shortened; costa thickened beyond stigma; stigma short, origin of R_{2+3} interstitial with cross vein r-m, or nearly so (p. 370), **Neanalcocerus**
3. First antennal segment twice length of second; vein R_{2+3} evanescent on apical half (p. 371).....**Lysozus**
   First antennal segment subequal in length to second; vein R_{2+3} complete.....4

4. Scutellum with a strongly developed median process, forked at end, which in one species reaches to apex of abdomen; or, if this process is not evident, the scutellar spines (really the above mentioned forks) are robust, longer than the scutellum, and curved inward at apex; middle femora, at least in male, with prominent irregular spines or dentitions below; metapleura each usually with a mammiform tubercle; vein R_4 absent (p. 371), **Dicranophora**

   Scutellum without a forked median process, only with the usual spines or unspined; middle femora and metapleura unmodified; vein R_4 usually present 5

5. Costa more or less thickened and expanded beyond stigma, at least in males conspicuously so; discal cell roughly diamond-shaped, though basal angle is definitely more obtuse than apical one; third and fourth posterior cells narrow, their combined width about equal to that of the first or second (p. 373) ..... **Histiodroma**

   Costa not conspicuously thickened; discal cell rectangular, pentagonal or hexagonal; third and fourth posterior cells each equal or nearly so, in width to first or second 6

6. Vein R_1 beyond point of separation from R_s greatly weakened; base of R_s strong; wings truncated at apex; discal cell quadrilateral, with lower apical corner rounded (p. 375) ..... **Cyclophleps**

   Vein R_1 not weakened at apex; vein R_s often evanescent at base; wings not truncated; discal cell pentagonal or hexagonal, the corners angular 7

7. Arista slightly dorsal in position; abdomen parallel-sided, or almost so (p. 376) ..... **Basentidema**

   Arista apical; abdomen broadening toward apex 8

8. Costal margin of first submarginal cell twice that of second; discal cell half again as long as broad, and lying chiefly beyond cross vein r-m (p. 377), **Hoplistes**

   Costal margins of first and second submarginal cells subequal; discal cell about as long as broad, or its elongation attained by extension basad of r-m (p. 378) ..... **Rhaphiocera**

Analcocerus Loew

Analcocerus Loew, 1855, Verh. zool.-bot. Ver. Wien, 5: 140, 147; Enderlein, 1914, Zool. Anz., 43: 597.

Campeprosopa Williston, 1900, Biol. Centr. Amer. Dipt., I, p. 239 (not Macquart, 1850).

To the characters given in the key the following may be added: the first and second antennal segments are subequal, but each elongated, being three to four times as long as wide; the sixth to eighth segments are concave posteriorly; the scutellum is two-spined; R_s is evanescent at its base, and R_1 weakened at the origin of R_s. The thorax and legs are without special modifications, except sometimes a thickening of the hind basitarsi.

Genotype, *A. atriceps* Lw., by original designation.

KEY TO THE SPECIES OF ANALCOCERUS

1. Abdomen with narrowly interrupted pale bands on posterior margins of segments one to five ..... **longicornis**

   Abdomen with a transverse band; not interrupted and not attaining lateral margins, on segment one, otherwise with only lateral margins pale, this color sometimes extending inward at incisures 2

2. Middle and hind tibiae brown ..... **atriceps**

   Middle and hind tibiae yellow 3

3. Front with a prominent yellow spot below ocelli; postocular orbits mainly yellow; scutellar spines no longer than scutellum, blackish, slightly divergent ..... **orbitalis**

   Front black immediately below ocelli; postocular orbits mainly black; scutellar spines longer than scutellum, yellow, strongly divergent ..... **taurus**

Analcocerus longicornis (Williston)

Campeprosopa longicornis Williston, 1900, Biologia Centr. Amer. Dipt., I, p. 239.

Described from a female from Omilteme, Guerrero, Mexico. I have seen no specimens. It is apparently an *Analcocerus*, however, in spite of Williston's statement that the antennae are seven-segmented. The abdominal markings will readily distinguish this species from the South American ones.

Analcocerus atriceps Loew

Analcocerus atriceps Loew, 1855, Verh. zool.-bot. Ver. Wien, 5: 140; Enderlein, 1914, Zool. Anz., 43: 597.

Of the new species described below, *atriceps* is closer to *taurus* than to *orbitalis*; but the scutellar spines are not especially long and divergent in the male, the tibiae are brown, and the green spots on the postocular orbits are wanting. The wings are clouded as in *taurus*. The thoracic and abdominal patterns in this and the two following species are, in general, similar.

Recorded by Enderlein from Santa Catharina, Brazil, and by Lindner from Itatiaya, Brazil. I have a male and a female specimen from Itatiaya, determined by Lindner.

Analcocerus orbitalis new species

Figure 2

Male.—Antennae about twice length of head; segments from lateral view of equal width, apical one rounded; ratio of length 11 : 9 : 2 : 2 : 2 : 5 : 6 : 15; first and second segments yellow, with short black pile; others black. Head black, prominently marked with yellow as follows: a large spot adjacent to ocellar triangle and occupying most of upper half of front, except along eyes; a spot adjacent to eyes on each side of front above antennae and one similarly placed on face below antennae, the two sometimes connected along ocular orbits; a spot on each side of oral margin; and postocular orbits, the yellow extending onto occiput near vertex; postocular orbits, however, are black above adjacent to eyes and black below adjacent to occiput. Proboscis black. Front at anterior ocellus wide as length of first antennal segment, somewhat wider at antennal bases. Thorax black, except following yellow areas: humeri; postalar calli and small triangle in front of and adjacent to them; two rather arcuate dorsal stripes which attain neither humeri nor postalar calli; scutellum; upper margin of pleura from humeri to wing bases, thence continuing in an oblique band across posterior margin of mesopleura onto sternopleura; and most of metapleura and hypopleura. Scutellar spines as long as scutellum or slightly shorter, brownish to blackish, sharp, slightly divergent. Pile of thorax inconspicuous, appressed, pale. Halteres yellow. Legs yellow, basal three segments of hind tarsi white, last segment of all tarsi brownish yellow. Wings hyaline, veins yellow. Abdomen black, marked with yellow as follows: a transverse band, separated from lateral margins, on first segment; lateral margins of dorsum and venter, narrow on venter and first and fifth seg-

ments dorsally, broader on other dorsal segments, on each of which it broadens toward posterior margin of segment; and sometimes a pair of small dorsal spots on second segment. Genitalia small, yellow. Length, 8 mm.

Female.—Differs but slightly from the male. All tarsi are whitish, except apically, and the bases of the tibiae, especially the front and hind ones, are brownish. The markings of the abdomen are greenish, but this probably has no significance.

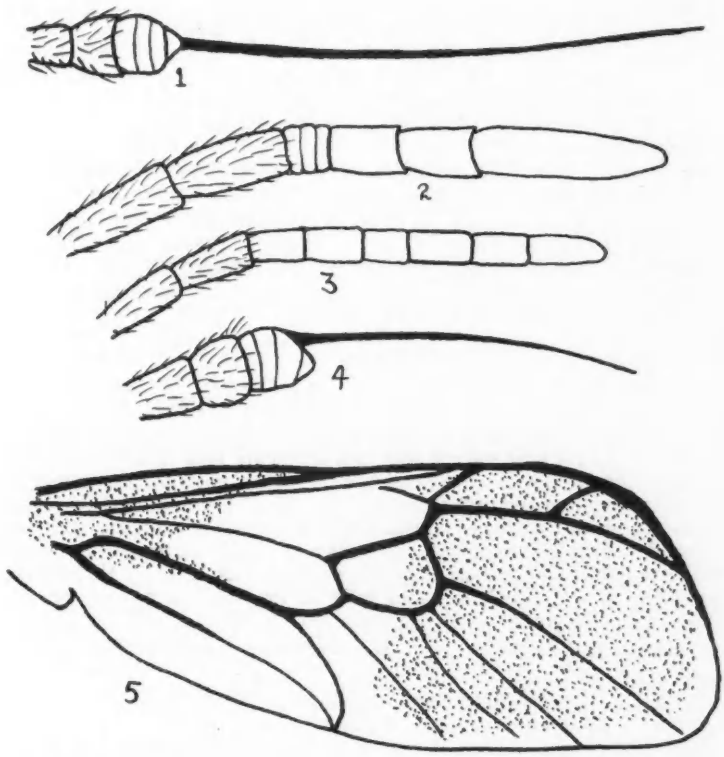


FIGURE 1. *Rhaphiocera armata* (Wied.), antenna. 2. *Analcocerus orbitalis* n. sp., antenna. 3. *Neanalcocerus hortulanus* (Will.), antenna. 4. *Basentidema coerulescens* n. sp., antenna. 5. *Cyclophleps tenebrifera* n. sp., wing.

Types.—Holotype male, Nova Teutonia, Brazil, Dec. 20, 1937 (Fritz Plaumann); American Museum of Natural History. Allotype female, same data, but Feb., 1939. Paratype males, same data, but Dec. 14, 1937, and Nov. 17, 1936.

Analcocerus taurus new species

Male.—Similar to the above species. Antennal structure practically the same. Head black, with a small green spot bordering each eye above antennae and another in like position below; postocular orbits on each side with a small green spot near upper angle of each eye. Thoracic pattern similar to that of ***orbitalis***, but markings greenish; upper pleural margins narrow; hypopleura black, variably marked with yellow; narrow base of scutellum black. Scutellar spines one-third again as long as scutellum, strongly divergent, slender, and sharp, brownish-yellow in contrast to green of scutellum. Legs yellow, tarsi on basal three segments white. Wings with a brownish cloud running lengthwise of the anal and second basal cells, and another at wing apex in first and second posterior cell. Abdomen marked as in ***orbitalis*** except that first abdominal segment is without a yellow margin and there are no spots in middle of second segment. Length, 8 mm.

Female.—Scutellar spines no longer than scutellum, only moderately divergent, and more robust than in male.

Types.—Holotype male, S. Sebastião, Brazil, Nov. (C. W. Johnson); Museum of Comparative Zoology, No. 25660. Allotype female, Parque Cajuru, São Paulo, Dec., 1911 (Schrobel); Museu Paulista. Also a male in teneral condition, not a type, Alto da Serra, S. Paulo, Nov. 29, 1908 (Luederwaldt).

Neanalcocerus new genus

Analcocerus Williston, 1900, Biol. Centr. Amer. Dipt., I, p. 238; Curran, 1934, North American Diptera, p. 143 and fig. 26; not Loew, 1855.

Distinguished from *Analcocerus* chiefly by the venation and antennal structure. First and second antennal segments long and slender, subequal in length; the other six subequal in length, each a little more than half the length of the first or second, the eighth segment slightly longer than the preceding ones. Costa strongly thickened apically (but not expanded as in *Histiodroma*), and ends near the blunt wing apex; discal cell small; cross-vein r-m very long, almost as long as the smaller diameter of the discal cell, and fully as long as the portion of vein M_{1+2} from the cross-vein to its furcation.

Genotype, *Neanalcocerus* (*Analcocerus*) *hortulanus* (Williston).

Neanalcocerus hortulanus (Williston)

Figure 3

Analcocerus hortulanus Williston, 1900, Biologia Centr. Amer. Dipt., I, p. 238.

Described from two females from Yucatan. A male in my collection, Acapulco, Guerrero, Mexico, June 15, 1936 (A. E. Pritchard), agrees well with Williston's description and illustration, with the following exceptions: the markings on the body are a bright, pastel green; the hind femora have a dark median annulus; and the hind tibiae are in large part brownish. The venation differs slightly from the illustration; vein R_5 bends downward slightly after it separates from R_4, and R_{2+3} originates slightly behind, almost interstitial with, r-m.

Lysozus Enderlein

Lysozus Enderlein, 1914, Zool. Anz., 43: 579.

According to Enderlein's diagnosis of the genus, the first antennal segment is four times as long as wide, the second twice as long as wide, and the arista set dorsally on the short oval flagellum; the scutellum is two-spined; and vein R_{2+3} vanishes at its apical half.

Genotype, *Lysozus columbianus* Enderlein, by monotypy.

Lysozus columbianus Enderlein

Lysozus columbianus Enderlein, 1914, Zool. Anz., 43: 579.

This species, the only one known, was described from one specimen from Colombia, and has not been recorded since.

Dicranophora Macquart

Dicranophora Macquart, 1934, Suites à Buffon, I, p. 255; Macquart, 1838, Dipt. Exot., I, 1, p. 195; Loew, 1855, Verh. zool.-bot. Ver. Wien, 5: 141.

This genus has several interesting peculiarities which are given in the key. To these characters it may be added that the antennae are short, with the arista terminal or slightly dorsal, and the wing is unmodified as to thickenings, truncation, etc., the only outstanding wing character being the lack of vein R_4, a character which I have not seen elsewhere in this subfamily except as an occasional abnormality in *Rhaphiocera*.

Genotype, *Dicranophora* (*Sargus*) *furcifera* (Wiedemann), by designation of Macquart (1838).

This genus seems to be poorly represented in collections. I have examined the types of *astuta*, *affinis*, and *brevifurca*; also a specimen of *furcifera* in the American Museum of Natural History. *D. picta* has been placed in my key on the basis of Macquart's description and figures.

KEY TO THE SPECIES OF DICRANOPHORA

1. Scutellar process reduced, hardly evident except for its furcations, which appear as strong bowed spines ..... **brevifurca**
   Scutellar process before furcation usually at least as long as rest of scutellum 2
2. Scutellar process prolonged to apex of abdomen ..... **furcifera**
   Scutellar process not extending beyond second abdominal segment 3
3. Abdomen wholly pale; mesonotum with a conspicuous triangular spot on each side in front of suture ..... **astuta**
   Abdomen black, with pale markings; mesonotum without lateral presutural triangles 4
4. First and second abdominal segments each with a conspicuous yellow spot in the middle ..... **affinis**
   First abdominal segment with a narrow yellow posterior margin, second wholly black ..... **picta**

Dicranophora brevifurca new species

Readily distinguishable from other described species by the very short scutellar process which, except for its terminal spines, would not be recognizable as such except by comparison with other species. This species, however, is clearly a *Dicranophora*, as evidenced by its other morphological characters.

Male.—Head yellow, marked with black as follows: ocellar triangle; a narrow band extending from ocellar triangle to each eye, thence bending backward narrowly along suture between vertex and occipital orbits, and connecting to center of occiput; a large bell-shaped spot on the front; and occiput, except orbits; also an indistinctly defined brownish area above antennae, and a spot of similar color to each side along oral margins. Front at middle one-third width of head, slightly narrower above and broader below. Face white pilose; front and vertex almost bare. Antennae yellow; first and second segments and annulated part of flagellum subequal, arista almost twice length of rest of antennae. Thorax black dorsally, marked with yellow as follows: humeri, supra-alar calli and adjacent areas, a pair of mid-dorsal stripes extending from humeri to a point three-fifths distance from suture to scutellum, and connecting stripes extending from this pair to the dorso-pleural suture and there expanding into larger spots. Scutellum yellow, narrow base and spines black; spines somewhat longer than scutellum, thick, divergent, but at the apex curving inward, blunt apically; what appear to be the spines probably represent the remains of the furcate scutellar process characteristic of this genus, but which in the present species is hardly recognizable as such. Metanotum black in center, its slopes yellow; pleura yellow, with a black spot above each middle coxa, one below each wing base, and one on each mesopleuron; prosternum black in middle, mesosternum with a large black triangle on each side, extending from middle coxa almost to front one; metapleura each with a prominent mammiform tubercle. Legs yellow; front tibiae and tarsi black, the former somewhat brownish below; hind tibiae narrowly at base and apex, middle knees, and last two or three segments of middle and hind tarsi black. Middle trochanters produced strongly below at point of articulation with coxae; their femora at about middle third below expanded into a stout tubercle with a jagged under surface composed of five or six teeth on the lower surface of the tubercle and four or five more basad to it. Halteres unusually large, yellow, more brownish at base. Wings hyaline; veins yellow. Abdomen yellow; beyond segment one dorsally obscurely brownish in middle, with yellow triangles on posterior margins of segments two to four, largest on two, smallest on four; venter yellow, unicolorous. Genitalia yellow. Length, 7 mm.

Types.—Holotype male, Villarica, Paraguay, October (F. Schade); Museum of Comparative Zoology No. 25661. Paratypes, male, same data, and male, Villarica, Paraguay, Dec., 1938 (Schade), C. W. Sabrosky collection.

Dicranophora furcifera (Wiedemann)

Sargus furcifer Wiedemann, 1824, Anal. Ent., 31, 40; 1830, Zweifl. Ins., II, p. 38.
Dicranophora furcifer Macquart, 1838, Dipt. Exot., I, 1, p. 195.

Type from Brazil. Macquart records this species from Rio de Janeiro.

Dicranophora astuta Williston

Dicranophora astuta Williston, 1888, Trans. Amer. Ent. Soc., 15: 250.

Type from Brazil.

Dicranophora affinis Williston

Dicranophora affinis Williston, 1888, Trans. Amer. Ent. Soc., 15: 251.

Type, ♀, from Rio de Janeiro. A male, Rio de Janeiro, Oct., 1919 (C. H. Curran), in the American Museum of Natural History, conforms with Williston's description.

Dicranophora picta Macquart

Dicranophora picta Macquart, 1834, Suites à Buffon, I, p. 255; Macquart, 1838, Dipt. Exot. I, 1, p. 196; Williston, 1888, Trans. Amer. Ent. Soc., 15: 250.

Type from Brazil.

Histiodroma Schiner

Histiodroma Schiner, 1867, Verh. zool.-bot. Ges. Wien, 17: 308; Schiner, 1868, Reise Novara, p. 68; Brauer, 1882, Denkschr. kais. Akad. Wiss. Wien, 44: 70.

Genotype, *Histiodroma* (*Sargus*) *inermis* (Wiedemann).

The three species known to me can be separated by the following key. A fourth species, *H. flaveola* Bigot, has been described from Mexico, but from the description alone it is impossible to determine whether the generic reference of this species is correct.

1. Wings with two conspicuous black bands, one crossing and including the discal cell and the other at the apex ..... **fascipennis**
   Wings yellowish, sometimes with a light shadow in the above regions, but never black 2
2. Abdomen black; scutellum with spines reduced to tubercles; first antennal segment twice as long as second ..... **inermis**
   Abdomen yellow; scutellum with spines strong; first and second antennal segments subequal in length ..... **tricolor**

Histiodroma fascipennis new species

A black species, with predominantly black legs and with conspicuously cross-banded wings.

Male.—Head black; front on its lower third with a pair of rounded or oval spots. Front about one-fifth width of head, parallel-sided; face about same width. Front almost bare; face, proboscis, cheeks, and occiput with whitish pile. Antennae, including arista, bright yellow; first and second segments subequal to each other and to annulated part of flagellum; arista one and two-thirds combined length of rest of antenna. Thorax black, except following areas, which are pale green: scutellum including spines; humeri; a small spot above each wing base; a pair of crescentic or oval spots running lengthwise of the disc, behind the suture; and an oblique band on each pleuron, consisting of the posterior margin of the mesopleuron connected with a squarish marking on the sternopleuron. Pile whitish. Legs black, shading to a variable degree to yellow; but usually the trochanters, the bases of the middle and hind femora and the middle and hind basitarsi, and sometimes also the bases and apices of the front femora, are yellowish. Halteres yellow, with green knobs. Wings subhyaline, with two broad black bands; the first fills the apices of the basal cells, the bases of the first submarginal and of the first three posterior cells, and all of the discal and fourth and fifth posterior cells; the second fills the apex of the wing from slightly before vein R_4;

there is also a shadow running lengthwise of the second basal and anal cells. Thickening of costal area extending beyond apex of R_4, but greatly narrowed at apical half of first submarginal cell, which is correspondingly widened. Abdomen black, with white pile; genitalia and apex of fifth segment yellow. Length, 7–8 mm.

Female.—Expansion of costal area much less marked; it is narrow at base and disappears near middle of first submarginal cell.

Types.—Holotype male, Cotía, São Paulo, Brazil, Dec. 27, 1940 (A. G. Silva); Instituto de Hygiene de São Paulo. Allotype female, Juquia, Faz. Poco Granda, São Paulo, Brazil, June 6–9, 1940 (F. Lane, Trav. Fo., and C. Carvalho); Museu Paulista. Paratypes: 5 males, same data as holotype; 1 male, 1 female, same data as allotype.

The species is subject to some variation. The legs, as already noted, vary in color; the cresentic spots of the thorax may be reduced or absent; the arista may be brown or black. The pale markings of the head and thorax may vary from green to yellow; frequently the spots of the head and sternopleura are yellow, although both may be green.

Histiodroma inermis (Wiedemann)

Sargus inermis Wiedemann, 1830, Auss. Zw. Ins., II, 31.
Histiodroma inermis Schiner, 1868, Reise Novara, p. 68.

Types from Brazil. Recorded from Rio de Janeiro by Williston.

Histriodroma tricolor James

Histiodroma tricolor James, 1940, Arb. morph. taxon. Ent., 7: 121.

A handsome species, superficially resembling *Hoplistes bispinosus*. The thorax is black, with green markings, the abdomen yellow. The types are males from La Merced, Chancomayo, Peru; in addition, I have seen 1 ♂, Peru, March 24, 1923 (C. H. Curran).

Histiodroma flaveola Bigot

Histiodroma flaveola Bigot, 1879, Ann. Soc. Ent. France, (5) 11: 205.

I quote the original description.

"Antennis obscure fulvis, apice et chaeto fuscanis; fronte et facie flavis; thorace flavo, vittis duabus longitudinalibus, subcontiguis, utrinque vitta lata abbreviata, interrupta, striga deinde laterali, nigro fusco, pleuris utrinque fusco late unimaculatis; scutello nigro, apice flavo; halteribus testaceis, apice fuscis; abdomine testaceo-flavo, nigro fusco late sex vittato; pedibus testaceis, femoribus apice, subtus, castaneo notatis, tarsis anterioribus apice fuscis; alis apice testaceis, intus et apice obscurioribus.

"Antennes d'un fauve obscur, plus foncées vers l'extrémité, chète noirâtre; face et front jaunes, une macule ocellifére, une demi-bande de chaque côté, partant du vertex et s'arretant à mi-distance des antennes aux bords des orbites, noires; thorax jaune, une double bande médiane, longitudinale, une large bande latérale, interrompue à la suture, n'atteignant pas les bords, une ligne joignant l'epaule à la base de l'aile, une large macule en dessous du prothorax, brun foncé; écusson jaune à bas noire; métathorax violet en dessus; balanciers testacés, massue noirâtre en dessus; abdomen d'un jaune testacé,

avec six large bandes, sises à la base des segmentes, atteignant à peine les côtés, d'un brun noirâtre; pieds testacés, cuisses teintées de brun en dessus, vers leur extrémité, surtout aux postérieures, tarses antérieurs largement teintés de brun a l'extrémité, pelotes testacées; ailes d'un testacé pâle un peu plus foncé au bord externe et sur les nervures.

"Mexicus. Ma Collection."

Cyclophleps new genus

Related to *Rhaphiocera*, and with the same general body form, but differing markedly in wing venation. First and second segments of antennae subequal to each other and to annulated part of flagellum; arista terminal. Scutellum with two strong spines. Legs without special modifications. Wing broadened at apex, truncated on upper apical angle; anal area weakly developed. Submarginal cells short and broad; discal cell about half again as long as its greatest breadth, roughly a rectangle, with the lower apical corner distinctly rounded. Vein R_{2+3} arising slightly before r-m.

Genotype, *Cyclophleps tenebrifera* n. sp.

Cyclophleps tenebrifera new species

Figure 5

Male.—Variegated yellow (or green) and black. Head yellow; center of occiput, a band on vertex including ocellar triangle, and another on upper part of front, black; the last mentioned connects along ocular orbits with vertical band, and below its outline is M-shaped. Proboscis, palpi, and antennae yellow; arista black, two and a half times length of basal part of antennae. Vertex about one-fifth width of head; front gradually widening to about two-sevenths head width at base of antennae. Postocular orbits much more strongly developed below than above. Dorsum of thorax much broader at wing bases than at humeri; black with humeri, supraalar calli, a large lateral triangle on each side in front of suture, two narrow stripes running from humeri to suture, two elongated-oval spots behind suture and not quite in line with the longitudinal stripes, and apex and posterior margin of scutellum, pale green or yellow. Post-scutellum and metanotum black. Pleura green or yellow; a diagonal stripe on mesonotum, a spot below each wing base, and one above each middle coxa, black; sterna in large part black. Halteres yellow. Coxae yellow, hind ones black anteriorly; trochanters mainly brown; basal third or more of all femora yellow; knees more or less yellowish; legs otherwise black. Wings hyaline, with marginal and submarginal cells, and entire apex of wing beyond a line running from crossvein r-m to apex of anal cell, black; extreme tip of wing not quite so dark; basal part of cubitus broadly margined with black; posterior margin of wing (posterior half of axillary cell) gray. Veins black. Abdomen black; first segment with lateral margins and large markings at posterior angles, second with a semi-elliptical spot on posterior margin and sharply divided into two spots by a median black band, third to fifth with lateral margins beginning beyond middle of third, yellow; venter wholly black. Genitalia small, yellow. Pile of body short, inconspicuous, mostly pale. Length, 12 mm.

Types.—Holotype male, paratype male, Iquitos, Peru, F 6062, Feb. 15, 1929 (H. Bassler), Collection Acc. 33591. American Museum of Natural History.

Basentidema Macquart

Basentidema Macquart, 1838, Dipt. Exot., I, 1, p. 197; Loew, 1855, Verh. zool.-bot. Ver. Wien, 5: 141.

Close to *Rhaphiocera*; as in that genus, the base of vein R_s is evanescent and R_1 is weakened or notched at the point of origin of R_s.

Genotype, *Basentidema syrphoides* Macquart, by monotypy.

KEY TO THE SPECIES OF BASENTIDEMA

1. Larger species (12 mm.); face black in middle; markings of thorax bluish-green; wings black along costal margin and infuscated at apex; tibiae and apices of tarsi black ..... **caerulescens**
   Smaller species (4.5–8 mm.); face yellow; markings of thorax yellow or fuscous; wings uniformly yellowish; legs yellow, bases of coxae and apices of tarsi sometimes black or blackish 2
2. Scutellum two-spined ..... **hortulana**
   Scutellum with denticles only ..... **syrphoides**

Basentidema hortulana (Wiedemann)

Sargus hortulanus Weidemann, 1830, Auss. Zw. Ins. II, p. 32.
Hoplistes hortulanus Williston, 1888, Trans. Amer. Ent. Soc., 15: 251.

Specimens which I have examined agree in every way with Macquart's description and figure of *B. syrphoides*, except for the larger size (7–8 mm.) and the presence of two strong scutellar spines. The two species must be closely related.

Type from Brazil; Williston records it from Rio de Janeiro. I have seen males from Batea, S. Paulo, Oct. and Nov., 1940 (John Lane); Rio de Janeiro, July (S. W. Williston); and Grajahu, Rio de Janeiro, June 20, 1939 (S. Lopes).

Basentidema syrphoides Macquart

Basentidema syrphoides Macquart, 1838, Dipt. Exot., I, 1, p. 197.

Length, according to Macquart, 2¼ lines (4.5 mm.). The scutellar spines are reduced to denticles, which, if Macquart's illustration is correct, are set at the outer angles of a rather broad scutellum, broader than in the above species.

Type from Brazil.

Basentidema coerulescens new species

Figure 4

A large, black species with attractive bluish-green markings, a definitely spined scutellum, and black tibiae.

Male.—Head black, marked with bluish-green as follows: a pair of spots on front, below ocelli; a pair of spots along each eye, reaching from lower part of front almost to oral margin, and expanding inwardly toward each other below antennae; and the occipital orbits almost to lower corner of eyes. Front almost as wide as diameter of an eye. Antennae, including arista, black, second segment, however, brownish; first and second segments and annulated part of third subequal, arista half again length of rest of antennae. Thorax black, marked

with bluish-green as follows: humeri and narrow stripe along each dorso-pleural suture to wing base, where it extends into a broad posterior margin of the mesopleuron and almost touches a large spot of similar color on the sternopleuron; postalar calli and adjacent triangle directed forward; a pair of dorsal stripes broadly separated in front from the humeri and in back from the scutellum and supra-alar calli; scutellum except its narrow base and spines; a large ovoid spot on each metapleuron; and a small one above each hind coxa. Humeri prominent; thorax broadest at wing bases. Coxae, trochanters, tibiae, and last two segments of tarsi black; hind tarsi whitish at base; basal three segments of other tarsi and femora yellow. Halteres green, blackish at base. Wings chiefly grayish hyaline, costal cell and anterior borders of first basal and anal cells black; remainder of basal cells hyaline; veins black. Discal cell short, as high as long, roughly pentagonal; vein R_5 after separation from R_4 bent downward. Abdomen black, marked with bluish-green as follows: a transverse band, broadly separated from sides, on first segment; rectangular markings extending approximately to median third of the segments, on posterior margins of segments two, three, and four; apical half of segment five; and narrow lateral margins beyond middle of second segment. Venter black. Genitalia mostly black, the hypopygium large. Length, 12 mm.

Female.—Transverse spots on abdomen smaller, and posterior margin of fifth segment reduced to two small spots; otherwise differs only sexually. The ovipositor is short, blunt, and thick, no longer and almost as stout as the male hypopygium.

Types.—Holotype male, Nova Teutonia, Brazil, Nov. 11, 1939 (Fritz Plaumann); American Museum of Natural History. Allotype female, same data but Nov. 10, 1939.

Hoplistes Macquart

Hoplistes Macquart, 1834, Suites à Buffon, I, p. 253; Macquart, 1838, Dipt. Exot., I, 1, p. 194; Loew, 1855, Verh. zool.-bot. Ver. Wien, 5: 141; Schiner, 1868, Reise Novara, p. 68; Enderlein, 1914, Zool. Anz., 43: 580; Lindner, 1931, Rev. de Ent., 1: 308.

Several workers (e. g. Williston, Schiner, Lindner) have doubted the distinctness of this genus from *Rhaphiocera*; but these doubts have arisen mainly from the fact that they were comparing *Sargus hoplistes*, and not the genotype, *Sargus bispinosus*, with *Rhaphiocera*. *S. hoplistes* belongs in *Rhaphiocera*; but *S. bispinosus* represents a valid genus.

The wings are long and unusually slender, and the venation is characteristic. The stigma is very short, and vein R_{2+3}, which arises slightly beyond r-m, runs almost parallel with the apical part of R_1; R_5 is developed basally, and R_1 is not weakened at the origin of R_5; the submarginal cells are narrow, the first, measured either along the costa or along R_{4+5}, being twice as long as the second; the discal cell is elongated beyond r-m, but extends but a short distance before it; the posterior veins are strong and extend almost to the wing margin. The legs are long, the basitarsi noticeably so, the hind ones being almost as long as their tibiae; the middle femora, at least in the male, are curved below with numerous small denticles on their entire length.

Genotype, *Hoplistes* (*Sargus*) *bispinosus* (Wiedemann), by original designation.

Hoplistes bispinosus (Wiedemann)

Sargus bispinosus Wiedemann, 1830, Auss. Zweifl. Ins., II, p. 32.
Hoplistes bispinosus Macquart, 1834, Suites à Buffon, I, p. 253; Macquart, 1838, Dipt. Exot., I, 1, p. 195.

Type from Brazil. I have seen specimens from Mallali, British Guiana (coll. Oldenberg), in the collection of the Deutsches Entomologisches Institut, and from Kamakusa, British Guiana (H. Lang), C. H. Curran Collection No. 31144.

Rhaphiocera Macquart

Rhaphiocera Macquart, 1834, Suites à Buffon, I, p. 253; Macquart, 1838, Dipt. Exot., I, 1, p. 196; Loew, 1855, Verh. zool.-bot. Ver. Wien, 5: 141; Schiner, 1868, Reise Novara, p. 68; Osten Sacken, 1886, Biol. Centr. Amer. Dipt., I, 25–27; Enderlein, 1914, Zool. Anz., 43: 580; Lindner, 1931, Rev. de Ent., 1:308.

Genotype, *Rhaphiocera* (*Sargus*) *armata* (Wiedemann), by monotypy.

KEY TO THE SPECIES OF RHAPHIOCERA

1. Abdomen and legs wholly black; vertex, front except just above antennae, and face black; wings deeply infumated with blackish; vein R_{2+3} long, about three-fourths as long as vein R_5 ..... **ornata**
   Abdomen black, with conspicuous lateral margin and cross-bands (interrupted except on first segment) yellow or green; legs largely yellow or green; face, front or both marked with yellow or green, but area immediately above antennae is black; wings hyaline or yellow, or irregularly infumated; vein R_{2+3} short, not more than half as long as R_5 2
2. Submarginal cells broad, the first, measured along radial sector, not more than three times as long as wide; discal cell relatively large, its lower angle (at union with r-m) equidistant from anterior and posterior wing margins; wings hyaline or uniformly yellow; front with two yellow spots below antennae; legs without conspicuously blackened segments (other than tarsi) 3
   Submarginal cells long and narrow, the first four or five times as long as wide; discal cell smaller, its lower angle much nearer to anterior than to posterior margin; wings more or less clouded; front usually black above, sometimes marked with yellow; tibiae black. A variable species, with several named varieties ..... **armata**
3. R_1 thickened beyond separation from R_s; wings short; the break in R_1 at origin of R_s not clearly evident; interrupted abdominal cross-bands linear; scutellum black at base ..... **hoplistes**
   R_1 not thickened; wings longer; R_1 clearly weakened at origin of R_s; interrupted abdominal cross-bands triangular; scutellum wholly pale .. **sancti-pauli**

Rhaphiocera ornata Macquart

Rhaphiocera ornata Macquart, 1846, Dipt. Exot., suppl. 1, p. 55.
Hoplistes ornatus Enderlein, 1914, Zool. Anz., 43: 580.

Enderlein referred this species to *Hoplistes* because of the elongation of the first submarginal cell; however, this elongation is to be found along the radial sector, not the costa, and is due to the elongation and slope of R_{2+3}. The discal cell, in the Ambato, Ecuador, specimens, is elongated basally; this character, however, is probably variable, though it may serve as a distinction of a separate species.

Type from Colombia. Recorded by Enderlein from Ecuador. Ecuador: Ambato, 2 ♀. Bolivia: Prov. Sara (Steinbach).

Rhaphiocera armata (Wiedemann)

Sargus armatus Wiedemann, 1830, Aus. Zweifl. Ins., II, p. 29.
Rhaphiocera armata Macquart, 1838, Dipt. Exot., I, 1, p. 196; Schiner, 1868, Reise Novara, p. 68; Williston, 1888, Trans. Amer. Ent. Soc., 15: 251; Enderlein, 1914, Zool. Anz., 43: 580; Lindner, 1931, Rev. de Ent., 1:308; Lindner, 1935, Rev. de Ent., 5: 399.

A highly variable species. Lindner (1931) illustrated and tabulated five varieties, namely *hansae, minaensis, stieglmayri, borgmeieri,* and *trans-hansae*; later (1935) he added a sixth, *zikani*. Of these, I have seen only the typical form, *hansae,* and *zikani*. Lindner's table and illustrations will serve better than any key to separate the varieties.

Recorded by Wiedemann, Macquart, Williston, Enderlein, and Lindner from various localities in Brazil.

Rhaphiocera hoplistes (Wiedemann)

Sargus hoplistes Wiedemann, 1830, Aus. Zw. Ins., II, 30.
Rhaphiocera hoplistes Schiner, 1868, Reise Novara, p. 69.
Hoplistes hoplistes Kertész, 1909, Catalogue; Lindner, 1931, Rev. de Ent., 1: 305, 309–10.

Known only from Brazil.

Rhaphiocera sancti-pauli Lindner

Rhaphiocera sancti-pauli Lindner, 1931, Rev. de Ent., 1: 309–10.

Type from São Paulo, Brazil. Brazil: Cotía, São Paulo, Dec. 27, 1940 (A. G. Silva); M. das Cruses, São Paulo, Jan., 1939 (M. Carrera); Ypiranga, São Paulo, Dec. 29, 1939 (E. Salim).

The following species are not known to me, but quite probably belong in this genus. (*Rhaphiocera?*) *brevis* Bigot, from New Caledonia, certainly does not belong here.

R. mipartita Macquart, 1846, Dipt. Exot., Suppl. I, p. 54; from Colombia (=*R. bipartita* Walker).
R. caloptera Osten Sacken, 1886, Biol. Centr. Amer. Dipt. I, p. 26; from Mexico.
R. pampina Osten Sacken, 1886, Biol. Centr. Amer. Dipt. I, p. 25; from Panama.
R. picta van der Wulp, 1879, Ann. Soc. Ent. Belgique, 22, Comp. Rend., 46; from Brazil.

LITERATURE CITED

Brauer, Friedrich. 1882. Die Zweiflügler der kaiserlichen Museums zu Wien, II.—Denkschr. kais. Akad. Wiss. Wien, 44: 59–89.
Enderlein, J. Gunther. 1914. Dipterologische Studien, IX, Zur Kenntnis der Stratiomyiiden mit 3-ästiger media und ihre Gruppierung. A. Geosarginae, Analcocerinae, Stratiomyinae. Zool. Anz., 43: 577–615.
Kertész, Kolomon. 1908. Catalogus dipterorum hucusque descriptorum, vol. 3; Budapest.
Lindner, Erwin. 1931. Beitrag zur Kenntnis der Sudamerikanschen Stratiomyidenfauna (Dipt.)—Rev. de Ent., 1: 304–312.
Loew, Hermann. 1855. Einige Bemerkungen über die Gattung Sargus, Verh. zool.-bot. Ver. Wien, 5: 131–148.
Macquart, J. J. 1834. Suites à Buffon (Histoire naturelle des insectes Diptères). Roret, Paris.
1838. Diptères exotiques nouveaux ou peu connus, part I. Roret, Paris.
Schiner, F. R. 1868. Reise der oesterreischichen Fregatte Novara um die Erde. Zoologischer Theil. Diptera. Wien.
Williston, S. W. 1888. Diptera Brasiliana, ab H. H. Smith collecta. Part I, Syrphidae, Stratiomyidae. Trans. Amer. Ent. Soc., 15: 243–257.
1900. Biologia Centrali-Americana Diptera, vol. I, supplement.

STUDIES IN NEOTROPICAL STRATIOMYIDAE
(Diptera)

VI. A New Genus Related to Adoxomyia

MAURICE T. JAMES,
Colorado State College,
Ft. Collins, Colorado

Collections of Stratiomyidae sent to me by Dr. H. de Souza Lopes of the Instituto Oswaldo Cruz and Dr. C. H. Curran of the American Museum of Natural History contained series of the interesting new genus described in this paper.

Leucoptilum new genus

Antennae much longer than head, ten-segmented; first two segments conical, largest apically, subequal, the first slightly the longer; third to eighth segments forming a fairly compact unit; ninth cylindrical, densely pilose; tenth slender, elongated, densely pilose. Eyes pilose, contiguous in male. Occipital orbits well-developed above in female, evanescent above in male and below in both sexes. Thorax broadest at wing bases, thence tapering both anteriorly and posteriorly; scutellum with two strong spines. Abdomen broader than thorax, somewhat longer than broad. Legs of usual length. R_{2+3}, R_4 and r-m present; discal cell pentagonal, contact with fifth posterior cell usually punctiform, or sometimes a distinct m-cu crossvein present. Genotype, *Leucoptilum plaumanni* James, new species.

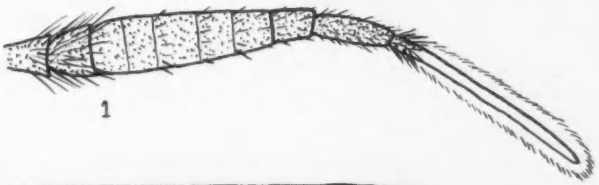
Related to *Adoxomyia*, from which it may easily be distinguished by the antennal structure, particularly the greatly elongated and pilose terminal segment (compare figures of Kertész, 1923, Ann. Mus. Nat. Hung., vol. 20, pp. 99 and 105, and Lindner, 1938, Die Fliegen der Pal. Reg., fasc. 18, p. 154). The general appearance is closer to some species of *Cyphomyia*; in fact, particularly in consideration of the occasional presence of m-cu, this may be a form intermediate between the two genera.

Leucoptilum plaumanni new species

Figures 1 and 2

Female.—Head shining black. Front coarsely punctured; at anterior ocellus half again as wide as at antennae; elevated in the middle, more depressed along ocular margins, but with a distinct polished, angularly margined elevation to each side of the antennae. Vertex separated from occipital orbits by a distinct groove; occipital orbits angular behind. Face small, parallel-sided. Proboscis and palpi yellow. Pile of head rather sparse, mostly appressed except on the face, whitish; that of eyes short, black. Antennae mostly black; segments three to six or seven may be more or less reddish; segment ten, except narrow base, yellow to white; pile black, except on yellow

parts of segment ten, where it is white; segment three devoid of pile, four or five to seven with definite semi-erect pile at base of each segment, eight more extensively pilose, nine and ten densely pilose; ratio of segments 5 : 4 : 4 : 3 : 4 : 3 : 4 : 5 : 8 : 23. Thorax shining black; pile fairly abundant, short, semi-appressed, yellowish on dorsum, more whitish on pleura and scutellum; scutellum triangular, spines about half length of scutellum, slightly incurved and yellowish at extreme apex. Halteres yellow. Legs mainly yellow; front femora brownish medially, middle ones brown on apical half, hind femora and tibiae black on apical half or more; hind tarsi white. Tarsi pale-pilose.



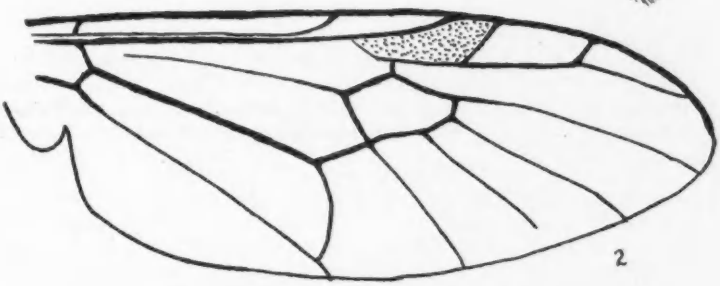


FIG. 1. *Leucoptilum plaumanni* James, antenna of holotype ♀.
FIG. 2. *Leucoptilum plaumanni* James, wing of holotype ♀.

Wings uniformly smoky brown, stigma and veins blackish brown; stigma and cell R_3 about as broad as basal cell; vein R_5 bent slightly downward after separation from R_4. Abdomen oval, slightly longer than broad, black, shining, with inconspicuous, short, black pile and with longer whitish pile on sides and venter. Length, 6–7 mm.

Male.—Antennae more slender; ratio of segments 4 : 3 : 2 : 2 : 3 : 2 : 3 : 5 : 8 : 18; densely black-haired beyond the base of the seventh, only the tip of the tenth being white-pilose. Face and frontal triangle small. Thorax with abundant, erect, pale yellow pile. Front and middle femora pale brownish; hind femora as in female; hind tibiae and basitarsi mainly brownish black; hind basitarsi enlarged, as thick as their femora, two thirds length of their tibiae, and as long as the remaining tarsal segments combined. Abdomen more slender, three-fifths as wide as long, pile more conspicuous, with much black pile on sides of fourth and fifth segments. Genitalia small. Otherwise as in female.

Types.—Holotype female, Nova Teutonia, Brazil, Feb. 24, 1938 (Fritz Plaumann); Collection of the Instituto Oswaldo Cruz. Allotype male, Nova Teutonia, Dec. 6, 1936, (Plaumann); American Museum of Natural History. Paratypes: 3 females, Nova Teutonia, Jan. 5, 1938, Feb. 10, 1938, and no date (Plaumann); 1 female, Angra dos Reis, Japuhuba, E. do Rio, Brazil (Trav. et Lopes); 1 female, Rio de Janeiro, Jardim Botanico (H. S. Lopes). Collections of the Instituto Oswaldo Cruz, the American Museum of Natural History, and the author.

Leucoptilum bassleri new species

Female.—Differs from *plaumanni* as follows: Pile of head denser; that of eyes inconspicuous, visible only under high magnification. Antennae as in *plaumanni*, but eighth segment more clearly separated from the preceding ones, and as conspicuously pilose as the ninth, and tenth black-pilose on basal third. Thorax with longer and denser pile, which is almost wooly and from certain angles conceals the ground color on dorsum and scutellum; scutellar spines two-thirds length of scutellum, yellow. Legs yellow; sub-apical ring of front and middle femora, and apical half of hind femora and tibiae, brown; hind basitarsi black-pilose. Infumation of wings almost uniform, but slightly less intense in first submarginal cell and toward basal half of wing. Length, 6.5 mm.

Type.—Holotype female, Lower Rio Tapiche, Peru, Aug. 23, F 6020 (H. Bassler Collection, Acc. 33591); American Museum of Natural History.

THE MICROSCOPE AND ITS USE, by FRANK J. MUNOZ and HARRY A. CHARIPPER. Pages xii+344, 6 x 8¾ inches, 122 figures. Published by CHEMICAL PUBLISHING COMPANY, INC., Brooklyn, New York. 1943. Price, $2.50.

The senior author of this book has for many years been connected with one of the large manufacturers and distributors of microscopes, and in this capacity has been called upon to solve many problems of various users of microscopes; the junior author is a professor of biology at New York University with many years of experience in laboratory research and teaching. These two men have collaborated to produce a comprehensive book on the use and care of the microscope, written in non-technical language. The book is not intended as a scientific treatise but as a guide to aid students and technicians in the use of this instrument.

The table of contents gives an idea of the scope of the book: I, The Evolution of the Microscope; II, The Modern Microscope; III, Illumination; IV, The Microtome; V, The Use and Care of the Microscope; VI, The Stereoscopic Microscope; VII, The Metallurgical Microscope; VIII, The Polarizing Microscope; IX, Accessories for Use with the Microscope; X, Common Errors in the Use of the Microscope; the remaining pages contain a table of magnifications, drawings illustrating the optics of a microscope, a glossary, bibliography, and index.

This is an excellent book for anyone who uses a microscope. It contains a great deal of practical information, and answers many questions that arise in the use and care of various types of microscopes and their attachments. It is written in clear, simple language, and is well illustrated. The advice it gives should lead to a more efficient use of the microscope.—D. J. B.

BIOLOGY OF THE IMMATURE STAGES OF THE CLEAR LAKE GNAT

(Diptera, Culicidae)

CHRISTIAN C. DEONIER,

United States Department of Agriculture,
Bureau of Entomology and Plant Quarantine,
Nice, California

The Clear Lake gnat, *Chaoborus astictopus* D. and S., is a nonbiting gnat of the family Culicidae. The species is known as the Clear Lake gnat because these insects breed in large numbers in the environs of Clear Lake, Calif. Studies from 1939 to 1941 on the life history and morphology of the immature stages of this gnat are reported herein.

LIFE HISTORY

Life-history studies of *Chaoborus astictopus* were conducted under controlled conditions and, when possible, under lake conditions. In 1937 Herms gave a brief resume of the life history of this species. A more detailed study by Lindquist and Deonier (manuscript) showed that adults began emerging in large numbers in the spring from the overwintering larvae at water temperatures of 62° to 70° F., but that during the fall pupation and emergence were greatly reduced at 70° and nearly ceased at 65°. The adults emerged between 11 p. m. and 6 a. m.; the sex ratio was 60.2 per cent males and 39.8 per cent females. The adults were found to have a preoviposition period of 36 to 48 hours or more which was spent on shore in bushes and trees. These authors also report on the flight habits and oviposition which begin at dusk. The eggs were found to be white when deposited but they turned brown over night. Hatching, on the surface and under water, usually occurred in 20 to 24 hours during the summer, although under some conditions a longer time was required.

The newly hatched larvae, which escape from the egg chorion through a longitudinal slit on the side in contact with the water, were free-swimming; apparently they did not migrate to the bottom mud of the lake during the daytime as did the later instars, as they were collected by the thousands with a plankton net. Information is difficult to obtain on the length of the developmental periods for the immature *Chaoborus* larvae in the lake because of the long-drawn-out periods of emergence and the overlapping broods of larvae. The only opportunity offered for such a study is early in the spring, especially if a heavy oviposition occurs, followed by a period unfavorable for the adults and further oviposition. Even then development could be followed only through the third instar since the fourth instars could not, with certainty, be distinguished from the overwintering larvae.

In May 1940, when the water temperature was 63° F., newly hatched larvae were not observed to feed until 3 days after hatching. The developmental period for the first instar in the lake was over

8 days. The shortest period of development from egg to fourth instar was 18 days.

In the laboratory the length of the first three stadia was determined at 70° and 80° F. (Table I), the instars in these cultures being determined by examining 10 larvae taken at random. The first stadium was abnormally long since food was not offered until the larvae were 4 days old. These stadia, which usually required from 8 to 15 days, were prolonged when temperature and food conditions were unfavorable; and extended periods of unfavorable conditions resulted in death of the larvae. The early instars developed more slowly at 70°, but the development of the third instar was just as rapid at 70° as at 80°.

TABLE I

DURATION OF LARVAL STADIA OF *Chaoborus astictopus* AT 70° AND 80° F. Eggs laid October 10, 1940, hatched October 11, larvae first given plankton October 15

AGE (days)	AT 70° F.				AT 80° F.			
	First Stadium	Second Stadium	Third Stadium	Fourth Stadium	First Stadium	Second Stadium	Third Stadium	Fourth Stadium
	Days	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*
7	10	.....	.....	.....	10	.....	.....	.....
8	10	.....	.....	.....	7	3	.....	.....
9	8	2	.....	.....	.....	10	.....	.....
10	7	3	.....	.....	.....	9	1	.....
11	.....	.....	1[1]	.....	.....	5	5	.....
12	1	8	1	.....	.....	4	6	.....
13	2	7	1	.....	.....	3	7	.....
14	.....	.....	.....	.....	.....	.....	.....	1[2]
15	.....	4	6	.....	.....	1	8	1
16	.....	1	8	1	.....	.....	6	4
17	.....	2	4	4	.....	.....	5	5
20	.....	.....	2	8	.....	.....	1	8
22	.....	.....	.....	10	.....	.....	.....	10

[1]Third instar found upon examination of more mature larvae in culture.
[2]Fourth instar found upon examination of more mature larvae in culture.

The fourth stadium is extremely variable in length. In the laboratory under optimum conditions it has been as short as 2 days and as long as 9 months. Development was checked and pupation prevented by either lowering the temperature to below 60° F. or withholding food. In several instances larvae lived for two to three months at low temperatures without food.

With an abundance of plankton and temperatures of 70° to 80° F. the larval period lasted from 11 to 25 days (Table II).

Overwintering larvae from the lake were forced to pupate during the winter by placing them in a medium at 70° to 80° F. and offering them an abundance of plankton containing Copepoda. The time required to get pupation in the laboratory from overwintering larvae decreased from 24 to 8 days as spring conditions developed (Table III).

The pupal period was from two to three days, usually two days. In repeated breeding-jar tests pupae which did not develop into adults in this time died. This period is similar to that found for ***Chaoborus punctipennis*** (Say) by Muttkowski (1918). The actual process of emergence of adults was observed on repeated occasions. The adult freed itself from the pupal skin in a few seconds and was capable of flying almost immediately, but if undisturbed it usually paused for a few minutes on the cast skin.

Male pupae (fig. 2) are distinguished readily from female pupae (fig. 1) by the sheathed male terminalia, in which the clasper is clearly visible, located ventrad of the anal fin.

TABLE II

LENGTH OF LARVAL STAGE OF *Chaoborus astictopus* AT 70° TO 80° F. WHEN FED AN ABUNDANCE OF PLANKTON

DATE EGGS HATCHED	DATE PLANKTON FIRST OFFERED	LENGTH OF LARVAL STAGE		
		Minimum	Maximum	Mean
		Days	*Days*	*Days*
April 28, 1940	May 1, 1940	15	25	19.2
April 26, 1940	April 27, 1940	15	24	19.1
April 29, 1940	April 30, 1940	13	21	14.1
April 30, 1940	May 1, 1940	11	22	14.5
May 2, 1940	May 2, 1940	14	22	18.4

TABLE III

LENGTH OF TIME REQUIRED TO BREAK THE OVERWINTERING STAGE OF *Chaoborus* LARVAE UNDER LABORATORY CONDITIONS

DATE LARVAE WERE TAKEN FROM LAKE	DATE PUPATION BEGAN	NUMBER OF DAYS
October 23, 1939	November 16, 1939	24
December 18, 1939	January 2, 1940	15
February 12, 1940	February 24, 1940	12
March 5, 1940	March 16, 1940	11
March 19, 1940	March 27, 1940	8

DESCRIPTION OF THE LARVAL INSTARS

Four instars were found with characters based on slight modifications of the mouth parts and anal fin, by which they could be recognized.

First instar.—The first instar, or newly hatched larva, has raptorial antennae. The postantennal filaments are absent. The prelabral leaflike appendages are present. The mandibles are well developed, but the mandibular fans are absent. The eyes are simple.

Second instar.—In the second instar the postantennal filaments are present. The mandibular fans are formed and have 6 or 7 rays, more

frequently 6. The eyes are simple. The anal fin has 12, 13, or 14 rays, usually 14.

Third instar.—The third instar has all the structures of the previous instars. The eye is simple in the early part of the third stadium, but frequently development of the compound eye is begun toward the end of this stadium. There are 10, 11, or 12 rays in the mandibular fan. The anal fin may have 15, 16 or 17 rays, but 16 rays are by far the most common. Of the 45 larvae examined, 38 had 16 rays in the anal fin.

Fourth instar.—The fourth instar, or mature larva, has 5 spines on each raptorial antenna, with the outer spines on each side slightly shorter than the middle 3. Ventrally, between the antennae and the labrum, are 5 pairs of postantennal filaments and 2 prelabral, leaflike appendages which are narrow lanceolate, the hairs on the anterior side giving them a serrate appearance. The labrum is cylindrical and elongated. The mandibles have 3 large, stout teeth and 2 smaller teeth with a spinelike tooth in the area between the smaller and larger teeth. The number of rays in the mandibular fan may range from 13 to 20. Fifteen rays are most commonly found. The number of rays in the anal fin may range from 15 to 20, but usually there are 18. Thirty out of 39 larvae examined had 18 rays in the anal fin. The development of the compound eyes is completed soon after this stadium is reached. Mature larvae are from 8 to 10 mm. in length. The structures of a mature larva are shown in figure 3.

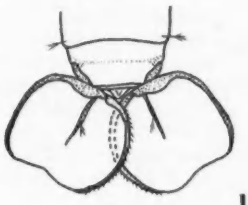
SYSTEMATIC RELATIONSHIPS

According to Johannsen (1934) the larvae of the genus *Chaoborus* resemble one another closely, differing chiefly in slight modifications of mouth parts and the anal fin. In the key for the larvae given by Johannsen, *C. astictopus* would come close to *C. punctipennis* var. *b.* Since larvae of other species were not examined by the author, a comparison could not be made. The number of rays in the mandibular fan of *C. astictopus* taken in Lake County, Calif., is especially variable. Larvae taken in May 1940, from Lake Pillsbury were found usually to have 20 or more rays. One specimen had 15 rays in one fan and 22 in the other. The number of rays in the mandibular fan of 12 larvae taken from Blue Lakes March 7, 1941, ranged from 15 to 20 as follows: 15 rays, 1; 17 rays, 1; 18 rays, 6; 19 rays, 2; 20 rays, 2. In ten larvae taken from Clear Lake March 13, 1941, examined, the number of rays in the mandibular fan ranged from 15 to 20 as follows: 15 rays, 6; 16 rays, 2; 17 rays, 1; 20 rays, 1. In Germany Peus (1934) found *Chaoborus* larvae to be variable, and he considers the prelabral leaflike appendage the most reliable character for separating the species. In individual larvae no relationship of these variations with similar variations in previous instars was indicated, since the appendages of each instar are formed against the body or in the head capsule, independent of previous structures which continue functioning until molting occurs.

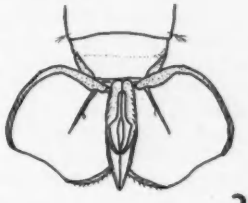
FOOD HABITS

Klugh (1927) reports that larvae of the genus *Chaoborus* are enemies of entomostracans. In the laboratory he observed them devouring *Cyclops fuscus, Simocephalus serrulatus,* and *Ceriodaphnia reticulata.*

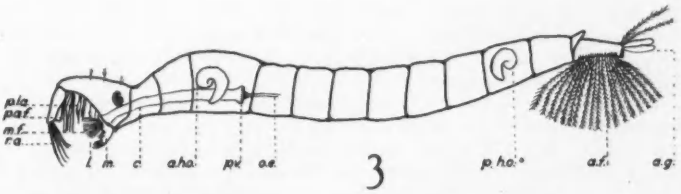
In discussing a paper by Knab (1909) presented at a meeting of the Entomological Society of Washington, Dyar stated that the larvae of *Chaoborus punctipennis* were very destructive to mosquito larvae in puddles near Washington, D. C. Muttkowski (1918) found the food of the species to be small worms and various components of plankton, specifically *Volvox*. Herms (1937) reports the larval food of *C. astictopus* to be algae and small aquatic animals and, in captivity, one another.



1



2



3

r.a. RAPTORIAL ANTENNAE
p.a.f. POST ANTENNAL FILAMENT
p.l.a. PRE-LABRAL LEAF-LIKE APPENDAGES
l. LABRUM
m.f. MANDIBULAR FAN
c. CROP (PHARYNGEAL BASKET)
a.h.o. ANTERIOR HYDROSTATIC ORGANS
p.v. PHARYNGEAL VALVE
oe. OESOPHAGUS
p.h.o. POSTERIOR HYDROSTATIC ORGANS
a.f. ANAL FIN
a.g. ANAL GILLS
m. MANDIBLES

Chaoborus astictopus: Figure 1, terminalia of ♀ pupa; 2, terminalia of ♂ pupa; 3, mature (fourth instar) larva.

The examination for food habits of the almost transparent larvae with its peculiar pharyngeal basket is relatively simple. The predaceous larva forces the whole captured organism into this basket, or crop, where mastication occurs. The contents of the crop can be emptied for identification by gentle pressure with a dissecting needle. Larvae were observed to empty the pharyngeal basket by reverse peristalsis, but the everting of the basket, as stated by Burgess and reported by Herms (1937), was not observed except in injured specimens.

Newly hatched larvae of *Chaoborus astictopus* were found to feed almost entirely on rotifers, primarily *Anuraea cochlearis* Gosse. Twenty larvae examined from the lake had this rotifer in their crops, although larvae were taken which had fed on other species of Rotifera. *A.*

cochlearis was the predominating species in Clear Lake, which may account for the high percentage of larvae feeding on this species. *Notholea* sp. was abundant in plankton samples from Blue Lakes in the spring of 1940, and first instars were found feeding on this rotifer. A newly hatched larva was found attempting to swallow an immature copepod. Although some Copepoda may be eaten by first instars, the size of most Copepoda would preclude their extensive use as food by this instar. On one occasion a larva was observed with phytoplankton in its crop.

The second instars fed on immature Copepoda and Rotifera. Eleven second instars taken from the lake had copepods in their crops. Four were found with rotifers.

Third instars were found to have the same food habits as the mature larvae. Nineteen individual specimens examined from the lake were found to be feeding on Copepoda.

The fourth instar, or mature larvae, feed upon Copepoda, chiefly *Cyclops* sp. and *Diaptomus* sp., both mature and immature forms. Tests were made in the laboratory on the kind and quantity of organisms ingested. Where larvae were permitted to select organisms at random from an abundant supply of Clear Lake plankton, *Cyclops*, *Diaptomus* and occasionally *Bosmina* were selected, and *Daphnia* was rarely taken. In feeding tests where the food supply was limited, larvae ingested *Daphnia*, blood worms, yeast cells, and Infusoria. The last two were probably taken accidentally while other organisms were being ingested. Dead organisms were refused.

In a feeding test on 20 overwintering larvae an average of 6.7 Copepoda were eaten. The same group ate an average of 8.3 Copepoda the following day. The number eaten depends on the size of the plankton organism. When food was abundant, larvae were observed to capture 12 *Cyclops* in 45 minutes. In the lake they are undoubtedly periodic feeders, since they are in the bottom mud during the day and migrate up into the lake at night.

Mature larvae feed readily upon small mosquito larvae offered them. The larvae are cannibalistic in all stages when the food supply is deficient.

LITERATURE CITED

Herms, W. B. 1937. The Clear Lake gnat. Calif. Agr. Expt. Sta. Bull. 607: 1–22, 10 figs.

Johannsen, O. A. 1934. Aquatic Diptera. Part 1. Nemocera, exclusive of Chironomidae and Ceratopogonidae. N. Y. (Cornell) Agr. Expt. Sta. Mem., 164: 1–71, 24 pls.

Klugh, A. Brooker. 1927. The ecology, food-relations and culture of fresh-water Entomostraca. Roy. Canad. Inst. Trans., 16: 15–98.

Knab, Frederick. 1909. The early stages of *Sayomyia punctipennis* Say. Wash. Ent. Soc. Proc., 10 (1908): 36–40, 4 figs.

Lindquist, Arthur W., and **Deonier, Christian C.** (Mss. in preparation.) Emergence of *Chaoborus astictopus* D. and S. from Clear Lake.

Lindquist, Arthur W., and **Deonier, Christian C.** (Mss. in preparation.) Flight and oviposition habits of the Clear Lake gnat, *Chaoborus astictopus* D. and S.

Muttkowski, Richard Anthony. 1918. The fauna of Lake Mendota: A qualitative and quantitative survey with special reference to the insects. Wis. Acad. Sci., Arts, Letters Trans., 19: 374–482, 1 map.

Peus, Fritz. 1934. Zur Kenntnis der Larven und Puppen der Chaoborinae (Corethrinae auct.). (Morphologie, Okologie, Entwicklungsbiologie). Arch. f. Hydrobiol., 27: 641–668, 12 figs.

CAECULUS PETTITI, A NEW SPECIES OF MITE FROM VIRGINIA

F. REESE NEVIN,
Cornell University, Ithaca, N. Y.

Banks (1899) described *Caeculus americanus* from two specimens collected at Palm Springs, California; the only other species of this genus that has been described from the United States is *Caeculus clavatus* (Banks, 1905), collected from among leaves near Washington, D. C. I have examined the type specimen of this latter species, and Jacot's material that is deposited in the Museum of Comparative Zoology at Cambridge, Massachusetts.

For a complete bibliography of the genus, see Jacot (1936).

General Characters of the Genus.—The arrangement of the larger setae on the legs, especially on the large first and second pairs of legs reminds one of the arrangement of the teeth in a wooden hand-rake, hence the name "rake-legged" mites. The number and the arrangement of these setae and of the smaller club-shaped or spatula-shaped setae on the legs and on other parts of the body are important taxonomically and in differentiating the various stages in the life history of the mite. There is, however, some variation in the number of setae as will be noted in the accompanying figures where, in some cases, a seta is present on one side of the body but is lacking on the other side. Nevertheless, the arrangement and numbers of setae are quite constant within the species.

The flattened dorsal surface with a series of sclerotized plates separated by wrinked cuticula, the presence of large eyes, and of spatula-like digits of the chelicera, are also generic characters.

Caeculus pettiti new species

Figures 1 and 2

Well sclerotized specimens are brown to black in color. Specimens not so well sclerotized are very light brown in color or are colorless, as are the unsclerotized areas of the cuticula of the colored specimens and of the larvae and most of the nymphs.

The size and shape of the body vary quite extensively, depending upon the degree of distention of the abdomen. When fully distended the wrinkles or folds in the cuticula between the various plates are somewhat smoothed out. The dorsal surface is in general quite flat, and the ventral surface somewhat more rounded in the region of the genital and anal plates.

Figures 1 and 2 of the dorsal and ventral surfaces respectively, show the areas of heavy sclerotization or plates.

The Dorsal Surface (fig. 1).—There are six dorsal and two postero-dorsal plates. The latter are only slightly colored and are not at all discernible in most specimens. The dorso-cephalic plate covers the entire capitulum and, as seen from above, extends posteriorly upon the notothorax to a point between the second and third pairs of legs.

This plate is heavier anteriorly and laterally, leaving a less heavily sclerotized area extending from the center of the plate to the transverse groove at the anterior edge of the median-dorsal plate. The cephalic plate bears 4 pairs of setae; one near the anterior margin,

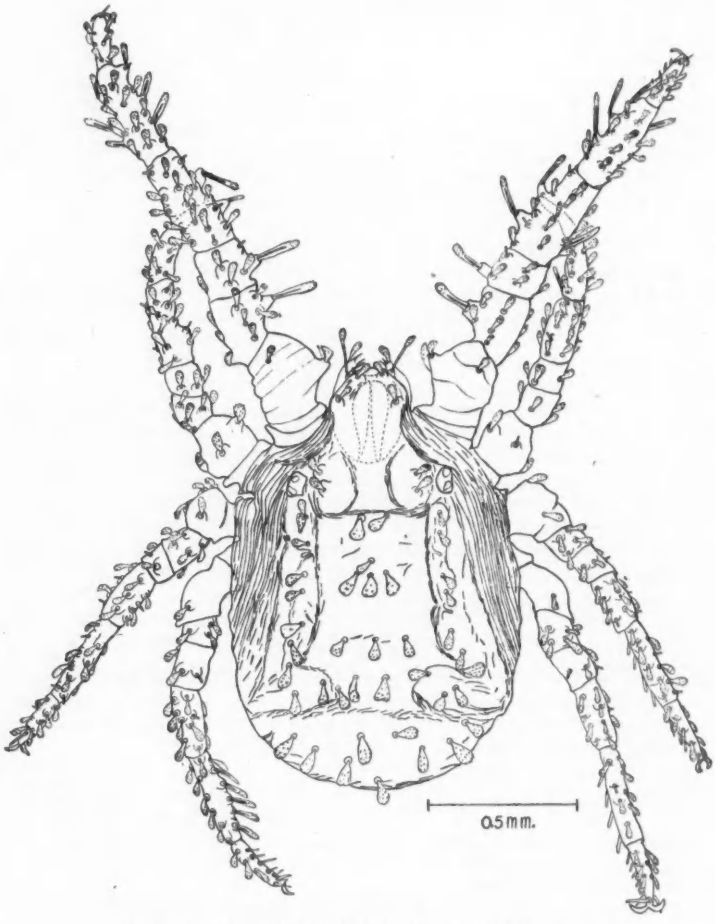


Figure 1. Dorsal view of adult *Caeculus pettiti*, n. sp.

one near the antero-lateral margin and the other two pairs in a postero-lateral position.

Beneath the cephalic plate is another plate which bears what appear to be pseudostigmatic organs. Pseudostigmatic organs are

generally not found in this position. The palpi in some specimens are not visible dorsally, but are concealed under the cephalic plate. In other specimens they appear as four-segmented structures with a digit attached jointly with the last segment.

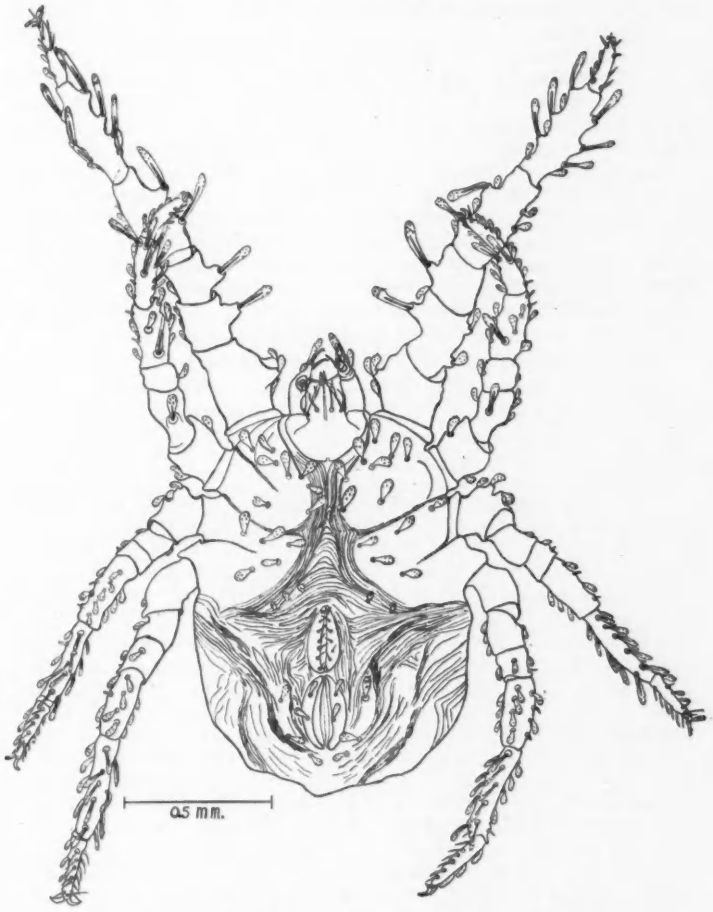


Figure 2. Ventral view of adult *Caeculus pettiti*, n. sp.

The median-dorsal plate is roughly square in outline, being slightly longer than broad, and broader posteriorly than anteriorly. The posterior margin of this plate may not be readily distinguishable since sclerotization may be no more complete than in posterior areas.

On this plate there are three rows of broad-tipped setae: the first row consists of one pair of setae, the second row, an irregular one of 3 or 4 setae, the third row of 2 or 3 setae near the posterior edge of the plate. Just posterior to this plate is another row of 3 setae. On either side of the median-dorsal plate is a narrow plate about four times as long as broad. Each of these plates bears 7 or 8 setae arranged in groups of 2 or 3, 2, and 3. Between each of these groups of setae are deeper grooves or openings in the heavy cuticula.

The eyes are located just opposite the two pairs of setae in the posterior region of the cephalic plate and are thus opposite the base of the second pair of legs. The eyes are divided, each part being covered with a heavy cornea. The location of the eyes is such as to give them a dorsal position in some specimens and a dorso-lateral position in other specimens depending upon the mounting of the specimen.

Caudad and mesad from the dorsolateral plate is a plate nearly oval in shape bearing three pairs of setae. This plate is distinct in some specimens, less so in others. Between the latter plates there are the three spatula-shaped setae mentioned above. Posteriorly are found at least four more pairs of setae and, in heavily sclerotized specimens, two postero-dorsal plates previously mentioned.

The Ventral Surface (fig. 2).—On the ventral surface there is a very definite genital plate bearing 7 pairs of short sharp spine-like setae. An anal plate with 2 pairs of club-shaped setae and a pair of lateral anal plates with one pair of club-shaped setae are present. The genital and anal plates are close together with no ventral plate between them.

The other sclerotized areas on the ventral surface are the flattened coxal plates, and the ventral surface or lower lip of the capitulum. I am not prepared to state what is the true nature of the structures which I have called coxal plates. I have previously (Nevin, 1935) described much narrower structures in *Cnemidocoptes mutans*, following the work of Buxton (1921), as epimeres. This term is also applied by Thor (1931). Jacot (1936) used the term parasterna as synonymous with epimera. Banks (1904) used the term coxa for these structures. Vitzthum (1933) used the term "coxalflächen" which I assume may be translated to mean coxal plates as well as coxal surfaces. These plates may correspond to enlarged sternopleurites of insects (Snodgrass, 1935). Coxal plates I and II are closely joined together as are III and IV. The first two bear 8 pairs of setae, the latter two 5 pairs of setae. In the midline between the right and left coxal plates are grooves or lines in the cuticula. In the drawing it was not possible to include all of these. The region between the genital plate and the fourth coxal plates bears a few setae which are rather hard to make out and which also appear inconstant in position in different specimens because of the wrinkled nature of the cuticula.

The lower lip bears 2 pairs of setae, the posterior pair long and quite slender, the anterior pair small. The chelicerae are located dorsal to this structure and may be seen through it. The digits of the chelicerae are shown in figure 2, and the body of the chelicerae are shown by means of dotted lines in figure 1. Dorsally or ventrally the

digits appear spatula-shaped ending in a chisel-like point. In lateral view the digit is sickle-shaped.

The Legs.—The accompanying drawings show the arrangement of the setae on the legs. The conspicuous structures of the first two pairs of legs are the large rake-tooth type of club-shaped setae. These are very heavy setae with a central dense, orange-colored structure. They terminate in a knob. These setae are set in wells in protuberances on the various segments of the legs. The arrangement of these setae on the segments of leg 1 is as follows: the large basal segment (described by Vitzthum as the trochanter and by Jacot as the coxa-trochanter) and the next distal segment bear one seta each on their mesal surfaces, the next distal segment bears two setae on the mesal surface and one on the distal or outer surface, the tibia bears three setae on the mesal surface and three on the outer surface. The tarsus bears none of the heavy type of setae but ends in two heavy claws. The other spatulate bristles and the smaller sharp bristles are accurately represented in the drawings. In some areas bluntly pointed setae seem to be arranged in rows with the spatulate setae. Where not symmetrically arranged these blunt setae may represent the cores of the spatulate setae.

Length, 1.3–1.44 mm.; average for four individuals, 1.37 mm.

This description of *C. pettiti* is based upon a study of 3 adults, sent to me by Dr. Lincoln C. Pettit of Washington and Lee University from Elk Creek, Grayson County, Virginia, and from a single adult from Lexington, Virginia. In these collections there were 11 nymphs and 13 larvae. These are of sufficient interest to warrant later description.

A potassium hydroxide treated specimen from Elk Creek is designated the type for the species. The drawings (figs. 1 and 2) were made from this specimen. The outline and as many of the details as possible were made under the camera lucida. It was necessary to study such details as the spines under the oil immersion objective. Some of the spines may thus be slightly exaggerated in size in the drawings.

LITERATURE CITED

Banks, Nathan. 1899. An American species of the genus *Caeculus*. Proc. Ent. Soc. Washington, 4 (3): 221–222.

1904. A treatise on the Acarina or mites. Proc. U. S. Mus., 28 (1382): 1–114.

1905. Descriptions of some new mites. Proc. Ent. Soc. Washington, 7 (2, 3): 135–136.

Buxton, P. A. 1921. The external anatomy of the Sarcoptes of the horse. Parasitology, 13 (2): 114–145.

Jacot, A. P. 1936. Some rake-legged mites of the family Cheyletidae. Jour. N. Y. Ent. Soc., 44: 17–31.

Nevin, F. Reese. 1935. Anatomy of *Cnemidocoptes mutans* (R. and L.), the scaly-leg mite of poultry. Ann. Ent. Soc. America, 28 (3): 338–367.

Snodgrass, R. E. 1935. Principles of insect morphology. McGraw-Hill Book Co., New York.

Thor, Sig. 1931. Einführung in das Studium der Acarina (Milben). Die Tierweld Deutschlands, 22: 1–78.

Vitzthum, H. Graf. 1933. Die Larvenformen der Gattung Caeculus Dufour. Zool. Anz., 105 (3, 4): 85–92.

A NEW SPECIES OF POLYBIA FROM PANAMA

(Hymenoptera, Vespidae)

J. C. BEQUAERT,
Museum of Comparative Zoölogy,
Cambridge, Mass.

Polybia barbouri, new species

Figure 1, A–F

A medium-sized black wasp, with the clypeus, propodeum, postscutellum and sometimes scutellum yellow. Wings mostly hyaline. Oculo-malar space obsolete. A fine humeral collar; no distinct propodeal groove. Genae and vertex separated from occiput by a raised line. Clypeus broader than high. Basal stalk of first tergite moderately long, passing gradually into the much wider apical portion.

Female.—Head moderately swollen, slightly wider than the thorax; seen in front, much wider than high; seen from above, broadly rectangular and a little over two and a half times as wide as long; occipital margin strongly curved inward. Upper half of gena (outer orbit) margined behind by a very fine raised line (placed rather far back) which continues between the vertex and the occiput. Genae well developed, in profile about two-thirds the width of the eye, somewhat swollen in upper third. Oculo-malar space very short, the eye almost touching the mandibular condyle. Inner orbits farther apart on the vertex than at the clypeus. Ocelli rather large, close together in an equilateral triangle; posterior ocelli three times as far from the inner orbits as from each other. Interantennal shield slightly raised, flattened medially, with a fine, short, impressed longitudinal line in the upper part; frons not appreciably swollen. Clypeus about one and one-third times as wide as high, transversely pentagonal, with all sides about equal, contiguous to the eyes over about one-half of the sides; anterior margin moderately produced into a broadly obtuse angle, with a blunt point. Mandibles and antennae as usual. Thorax about one and a third times as long as high in profile; pronotum evenly curved anteriorly, dorsally with a distinct but low and very finely carinate humeral ridge, which is very broadly interrupted medially; humeral angles not in the least projecting; pleura as usual; mesonotum longer than wide, semi-elliptical anteriorly; scutellum and postscutellum rather strongly swollen, with deep sutures; propodeum rather short and broad, without groove or concavity, medially with a very weak raised line over apical two-thirds. First abdominal segment elongate pear-shaped seen from above, about one and a half times as long as its greatest apical width, about two-thirds the length of the second tergite in profile; basal third forming a parallel-sided stalk, about one-fourth the width of the apical portion which widens gradually behind the stalk; spiracles not projecting; in profile the wider apical portion is little swollen and slants gradually to the stalk. Legs and venation as usual.

Dull, except over median slope of propodeum, clypeus and mandibles. Entirely covered with microscopic, alutaceous sculpture, nearly impunctate. Preapical portion of clypeus and mandibles with a few, widely spaced medium-sized punctures. An extremely short, somewhat silvery pubescence; longer erect hairs very few, particularly over apical area and at apical margin of clypeus, on the mandibles and (very sparsely) on the sides of the propodeum. Eyes bare.

Black, conspicuously marked with pale sulphur-yellow as follows: clypeus (sometimes with irregular brownish blotches in the upper median area); lower inner orbits and most of frons below antennae;

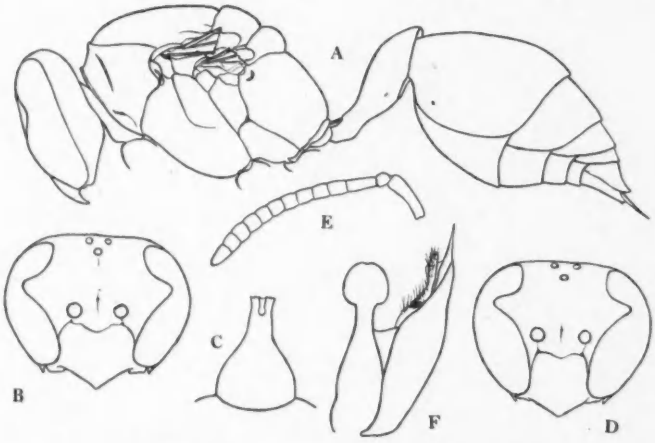


FIGURE 1. *Polybia barbouri*, new species. A-C, female holotype; A, body in profile; B, head in front view; C, first tergite of abdomen from above; D-F, male allotype: D, head in front view; E, antenna; F, terminalia.

a spot over basal third of mandible; under side of scape; hind margin of pronotum at least in the middle (in one paratype over most of pronotum); a spot in upper corner of mesepisternum; sometimes a streak on upper plate of metapleuron; most of the slanting median area of propodeum; entire postscutellum; part or most of scutellum (usually either along hind margin only or forming also spots on the disk); and sometimes traces of an apical band at the sides of tergite 1 (in one paratype a complete narrow apical band and a median dot behind the extensory muscle). Legs somewhat brownish-black; tibial spurs and claws testaceous-brown. Wing mostly hyaline, slightly infuscate in the costal, the apex of the subcostal and most of the radial cells; veins blackish-brown; stigma somewhat paler in the center.

Length (head+thorax+tergites 1+2): 8 mm.; of fore wing, 7.5 mm.

Male.—Similar to the female. Eyes larger. Clypeus about as wide as high, more regularly pentagonal, densely covered with silvery pubescence; anterior margin slightly produced and very bluntly

pointed medially; outer orbits (genae) very narrow, about one-fourth the width of the eye in profile; antennal sockets nearer the eyes. Antennae of 13 segments; scape much shorter than in the female; 13th segment about twice as long as wide at base; flagellum russet beneath. Terminalia (fig. 1, F): aedeagus with a heavy, simple shaft, ending in a broadly oval, flat spoon, with rounded edges. Prosternum, under side of fore and mid coxae, and spots on mesosternum and on hind coxae yellow.

Length (h.+th.+t. 1+2): 7.5 mm.; of fore wing, 7.2 mm.

Panama: Barro Colorado Island, Canal Zone, female holotype, male allotype and several paratypes of both sexes (Nathan Banks; J. C. Bradley; and Otis E. Shattuck). Holotype, allotype and paratypes at Mus. Comp. Zoöl., Cambridge, Mass.; paratypes also at Dept. of Entomology of Cornell University, U. S. National Mus., American Museum of Natural History, and Academy of Natural Sciences of Philadelphia.

In Ducke's key to the Neotropical *Polybia* (1910, Ann. Mus. Nat. Hungarici, VIII, pp. 491–496) *P. barbouri* runs out to couplet 29, which contrasts *P. catillifex* and *P. fastidiosuscula*. It is readily separated from *P. catillifex* Moebius and the related *P. nidulatrix* J. Bequaert by the presence of a fine raised line between genae and occiput, in addition to the very different coloration. From *P. fastidiosuscula* de Saussure it is distinguished by the bare eyes, the much broader first tergite and the color pattern. The bare eyes, presence of a raised line between genae and occiput, and lack of discrete punctures on the thorax differentiate it from *P. nigratella* R. du Buysson (see J. Bequaert, 1943, Jl. New York Ent. Soc., L, for 1942, p. 300). A Central American form of *P. occidentalis* (Olivier) (var. *spilonota* Cameron) is somewhat homeochromic with *P. barbouri*, but, like all varieties of *occidentalis*, it is smaller and lacks the ridge of the humeral margin. The lack of a median concavity on the propodeum separates *P. barbouri* from *P. jurinei* de Saussure and *P. signata* Ducke, which are somewhat similar in color pattern.

P. barbouri is named for Dr. Thomas Barbour, to whose initiative and perseverance the biological laboratory of Barro Colorado Island in Gatun Lake owes its existence.

A nest from which some of the paratypes were taken and now at Cornell University, was sent to me by Mr. H. Dietrich, together with Dr. J. C. Bradley's field notes. It was placed about 10 feet above the ground in a small tree in the forest. The inmates, it was noted, were "not more than moderately bellicose." The structure is bell-shaped, about 12.5 cm. long and 7 cm. wide, entirely built of paper, and of the type of architecture usual in the genus *Polybia*. When found, it comprised seven horizontal, slightly curved combs, with the convexity downward, where the cells open. The individual cells are about 10 mm. long and 3.5 mm. wide. This nest agrees well with figures published by P. Rau of nests found on Barro Colorado Island and attributed by him to *Polybia signata*, after the late Miss Sandhouse's identification (1933, Jungle Bees and Wasps of Barro Colorado, pp. 73–75, figs. 29–31). There can be little doubt that Rau's observations on these nests and the habits of their inmates refer to my *P. barbouri* and not to the South American *P. signata* Ducke. Rau noted that his wasp stores honey in the nest.

STUDIES ON THE GASEOUS SECRETION OF TRIBOLIUM CONFUSUM DUVAL

II. The Odoriferous Glands of Tribolium Confusum

LOUIS M. ROTH,
Washington Square College, New York

INTRODUCTION

It has long been known that *Tribolium confusum* Duval gives off an odoriferous substance. Chittenden (1896) noticed that a few flour beetles were enough to give a "persistent and disagreeable odor to the infested substance." The gas given off by the Tribolium adults deleteriously affects the viscous and elastic properties of a dough made from infested flour (Payne, 1925). Park (1934) reported that Dr. John Stanley believes ". . . the gas along with certain fluids found in Tribolium may be irritating to man resulting particularly in gastric disorders." However, from experiments on rats and man, there is no evidence that injury would result from the ingestion of confused flour beetles as they may accidently occur in cooked cereals (Mills and Pepper, 1939). Abnormal adults have been obtained by subjecting immature stages of Tribolium to the vapors of the secretion (Chapman, 1926). Roth and Howland (1941) isolated the substance and also obtained interesting monstrosities by subjecting different stages to both the fumes and crystals of the secretion. However, although many interesting facts have been established concerning this substance, the organs which produce the material have never been described. Good (1936) states that the scent glands of both *Tribolium confusum* and *T. castaneum* are well developed and are possessed by the adults but not by the larvae.

It is the purpose of this paper to describe the development and structure of these odoriferous glands from a study of them in the living condition and from fixed preparations, and to report other interesting data which have been noted during this investigation.

The author wishes to take this opportunity to thank Dr. Ruth B. Howland, under whose supervision this work has been carried out, and Dr. Roberts Rugh for his generous aid in photographing the material.

MATERIALS AND METHODS

The insects were reared in the manner described by Roth and Howland (1941). Eggs were sifted out of a medium made up of whole wheat flour (Wheatsworth) and powdered unirradiated yeast[1] which had been previously sifted through a number 3 bolting cloth and innoculated with about 50 adults. Two hundred eggs per 80 gms. of wholewheat flour per finger bowl were reared at 27° C. The various stages used were sifted from the flour when needed.

[1]The author wishes to thank the Fleischmann Laboratory (Bronx) for a supply of unirradiated yeast.

The glands were studied in the living condition by vital staining with a very dilute solution of methylene blue. Serial slides were also made of pupae and adults of various ages. These were fixed in Dietrich's solution,[2] Carnoy-Lebrun,[3] and alcoholic Bouin's. Dietrich's was found most satisfactory. Sections were cut at 7 and 8 mu. and stained with Delafield's haematoxylin and eosin.

Since varied and numerous techniques have been employed throughout this investigation, it is felt that for the sake of clarity these should be described in the section of the paper with which each is concerned.

DESCRIPTION

TIME OF APPEARANCE OF THE SECRETION

The odoriferous substance given off by *Tribolium confusum* Duval is an oxidizing compound and by merely holding a beetle on acidulated KI starch paper a characteristic blue black color (starch test) appears. This is a result of the iodine, released from the KI, combining with the starch.[4] This simple test provides an excellent method for determining when the secretion first appears. However, before this test could be shown to be valid it was necessary to prove that only the yellow oil taken from the reservoirs will give a positive iodine reaction. This was done in the following manner. Some permoplast was placed at the bottom of a Syracuse dish and a small depression, large enough to hold the head and thorax of the adult beetle, was made. The beetle was then inactivated on ice and its head and thorax were placed in the depression and covered by the permoplast, thus holding the animal somewhat solidly. The elytra and wings were then pushed forward toward the head and embedded firmly in the permoplast, exposing the abdominal reservoirs through the dorsal wall of the animal. Micropipettes were then drawn from .22 mm. pyrex tubing and these were attached to an injection circuit similar to that used on a Chambers micromanipulator. The point of the micropipette was inserted into various parts of the body of the beetle. Generally suction was not necessary since capillary action caused the body fluids to flow up into the pipette. The liquid was then either forced out of the pipette by pressure on the syringe, or the point of the pipette was broken and crushed, on strips of acidulated KI starch paper, to see if there was any discoloration. All of the body fluids taken from parts other than the reservoirs gave a negative reaction. These fluids were usually colorless except when some organic tissue was sucked up into the pipette, making it appear grayish. Only the yellow fluid taken from the reservoirs themselves gave a positive reaction.

Larvae of all instars, prepupae, pupae, and adults were irritated

[2]The formula for Dietrich's solution is:

Distilled water	60 cc.
95% alcohol	30 cc.
40% formalin	10 cc.
Glacial acetic acid	2 cc.

[3]Carnoy-Lebrun consists of equal volumes of absolute alcohol, glacial acetic acid, and chloroform, saturated with mercuric chloride.

[4]This test was originally suggested by Prof. K. C. Blanchard, of Washington Square College, as a test for an oxidizing substance.

(by stroking with a pair of forceps or needle) or crushed on acidulated KI starch paper (see fig. 14, Pl. II) to determine at what developmental stage the secretion appears. Pupae were separated into three distinct stages according to morphological changes in pigmentation:

Stage I. Pupa completely white or light tan. Eye pigmentation ranging from very light to dark. Mouthparts and legs not pigmented. (1 to 7 days after pupation at 27° C.)

Stage II. Eyes and tips of mandibles darkly pigmented. Tarsal claws brown and easily distinguishable. Antennae and legs not yet pigmented. (About 8 days after pupation at 27° C.)

Stage III. Eyes and tips of mandibles black. Genae dark brown. Antennae, tibiae and tarsi of legs light or dark brown. Tarsal claws moving freely within the pupal skin. (About 9 days after pupation at 27° C.) The entire pupal period lasts approximately 9 days at this temperature with humidity uncontrolled.

The sexes were separated in the pupal stage by the characteristic difference in the genital segment. The animals were considered emerged when the head, thorax, and prothoracic legs were out of the pupal skin. All tested animals had been raised at 27° C. until shortly before emergence as adults. These adults were isolated immediately after emergence, placed in Syracuse dishes (with filter paper on the bottom to give them a foothold) and then were tested, at room temperature, on the acidulated KI starch paper at definite intervals. Once tested, the animals were discarded. If no reaction was obtained by irritating the adults, they were then crushed on the test paper for it was found that occasionally the beetles may not give off the secretion voluntarily even though their sacs contain some of the substance. The results are shown in Table I.

From Table I it is possible to conclude the following:

1. There is no detectable secretion in larvae of all instars and in prepupae.
2. The substance appears at the same time in both male and female adults.
3. The secretion may first appear in very late pupae, or those which are just ready to emerge. At this time the positive reaction comes from the thorax only. However, since so few of these individuals give the positive test we may say that in general pupae do not possess any secretion.
4. Newly emerged adults possess the secretion in the thorax only. At this time the substance may be given off voluntarily if the beetle is disturbed. The starch reaction is generally much weaker than that of older beetles. However, a few individuals give a negative reaction to the test at emergence.
5. The secretion may be present in the abdomen one hour after emergence. It is definitely present in this region two hours after emergence but the reaction from the abdomen is much weaker than that obtained from the thorax of the same animal.
6. There is a decided increase in the amount of secretion with increase in age. This is shown by the increase in the intensity of reaction with KI starch paper and also by dissecting beetles of different ages and observing the volume of fluid in the sacs.

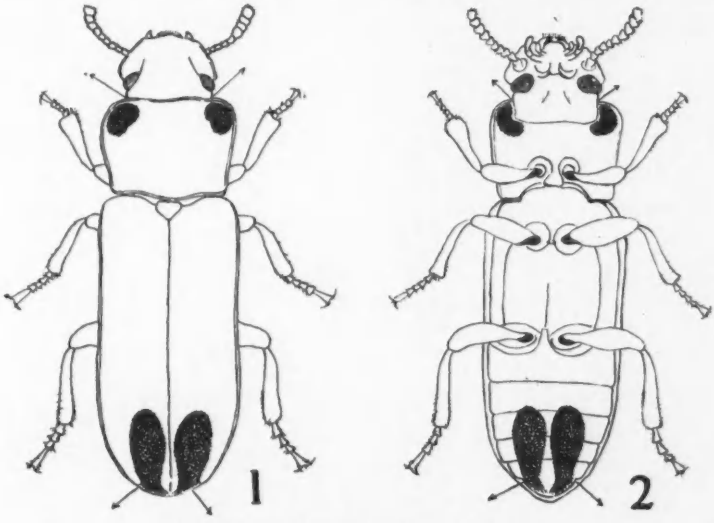
TABLE I

RESULTS OF TESTING DIFFERENT STAGES OF TRIBOLIUM FOR THE PRESENCE OF THE SECRETION (AT ROOM TEMPERATURE)

Developmental Stage	Reaction + or —	Number of Animals Tested	Remarks
Larvae (all instars)	—	50	All of the larvae were crushed on acidulated KI starch paper.
Prepupae	—	25	Same as for larvae.
Pupae (males)			
Stage I	—	50	All of the pupae were crushed on the test paper. In the 6 individuals of Stage III, the + reaction came from the thorax only and was not given off voluntarily. These beetles were probably just ready to emerge.
Stage II	—	50	
Stage III	—	55	
	+	6	
Pupae (females)			
Stage I	—	50	Same as for male pupae.
Stage II	—	50	
Stage III	—	60	
	+	14	
Adults (males) Time after emergence.			
0 min.	—	5	The + test was given by beetles which had just emerged or were only partly out of their pupal skins. The reaction was obtained from the thoracic region only and the animals gave off the gas when stroked with a brush. The iodine reaction was much weaker than that obtained from older beetles.
	+	42	
30 min.	+	21	Reaction was obtained from thoracic glands only.
60 min.	+	29	19 individuals gave a thoracic reaction only. 10 animals gave a + test from both thorax and abdomen, but the abdominal reaction was much weaker than the thoracic one of the same animal.
90 min.	+	21	5 animals gave a thoracic reaction only, while the other 16 gave + tests from both thorax and abdomen.
120 min.	+	35	All animals gave a + reaction from both the thorax and abdomen but the abdominal discoloration was still, generally, weaker than the thoracic one. After two hours the reaction obtained from both the thorax and abdomen increased in intensity with increase in age of the beetle.
Adults (females) Time after emergence			
0 min.	—	4	Same as for male adults.
	+	74	
30 min.	+	12	Reaction from the thorax only.
60 min.	+	39	28 gave + tests from the thorax only. 11 gave reactions from both the thorax and abdomen.
90 min.	+	17	8 gave + tests from both thorax and abdomen. 9 gave tests from thorax only.
120 min.	+	27	Same as for males.

EFFECT OF INANITION ON SECRETORY ACTIVITY

Starvation apparently has no effect on the initial production of the secretion. Some adults which had been isolated from food on emergence, showed full turgid abdominal and thoracic reservoirs after eight days of starvation (Pl. II, fig. 12). However, others show a quantity of secretion in the thoracic sacs only. After thirteen days of starvation, individuals generally show little secretion in their sacs (Pl. II, fig. 13) and generally less than individuals starved for eight days. This may indicate that if any secretion is given off within this period the beetle cannot manufacture new oil unless provided with food. Since starved adults can produce the secretion it is apparent that this substance is originally manufactured from the food materials taken in during the larval period and stored in some form until converted into the odoriferous substance by the secretory cells of the adult.



Text Figure 1, dorsal view; 2, ventral view.

Drawings of adult Tribolium showing the position of the turgid thoracic and abdominal reservoirs (stippled areas in the thorax and abdomen). The arrows indicate the regions from which the substance is emitted.

THE ODORIFEROUS GLANDS AND ACCESSORY STRUCTURES

The odoriferous glands of both male and female adults are equally well developed and consist of two main structures, namely, the glandular secreting cells themselves which lead (by means of small ducts) into a large chitinous reservoir or sac for storing the secretion. The adults possess two pairs of functional glands, one pair prothoracic, the other abdominal. There are four openings, one for each reservoir (Text Figs. 1 and 2). The various parts of the system will now be described separately.

The Abdominal Reservoirs.—When the elytra and wings of an adult, whose sacs are full of secretion, are removed or pushed aside, the reservoirs in the abdomen can be seen through the tergum since the dorsal cuticula is not melanized. These large sacs are filled with a yellowish fluid. The amount of fluid in the sacs, and therefore the volume of the reservoir, varies with the age of the individual. The older the beetle generally the more oil and therefore the larger the reservoir. The sacs appear as two large yellowish elliptical bodies, lying on either side of the digestive tract, and when full usually take up the last three abdominal segments. The size and shape of the sac may be somewhat obscured by fat bodies or by the intestine and reproductive tract which run between them.

The reservoirs can be removed from the body by holding the anterior part of the abdomen with a needle and pulling the last abdominal segment away with another needle. In this way the reproductive and digestive tracts and the odoriferous glands are all freed from the rest of the body but remain attached to the last abdominal sclerite. When freed in this manner, the reservoirs expand and become somewhat pear-shaped, as they are no longer under the influence of body pressure (Pl. I, fig. 2).

Serial sections show that the sac is formed by an invagination of part of the insect cuticle. This membranous wall is not as thick as the cuticular wall surrounding the insect's body (Text Fig. 3). As the reservoirs are insoluble in concentrated H_2SO_4, they should be a continuation of either the epi- or exocuticle. The endocuticle is soluble in concentrated acids, and the unknown chemical substance which has the power to resist solubility in concentrated H_2SO_4 is present only in the epicuticle while in the exocuticle it is incorporated with the chitin and protein (Wigglesworth, 1939). If the entire sacs are placed in this medium, the acid changes the yellow fluid to a deep red which may appear black because the mass is opaque (Pl. I, fig. 4). When placed in KOH or NaOH, the yellow contents of the sac become black. The reservoirs are not soluble in hot KOH (caustic potash) or hot 50 per cent NaOH. Therefore the reservoir is not part of the epicuticle since cuticulin which makes up the cuticle is soluble in hot alkalies. The epicuticle contains neither chitin nor protein (Wigglesworth, 1939). This leaves only the exocuticle as the part of the cuticle which forms the reservoir.

To determine if the reservoirs contain chitin, the abdominal sacs were subjected to the tests for chitin by the technique described by Campbell (1929). Turgid abdominal reservoirs were dissected away and left attached to their last abdominal sclerites (Pl. I, fig. 2). These were placed in 3 cc. of saturated KOH, in a shell vial (¾″ x 3″) and heated slowly in a paraffin bath to 160°C. and kept at that temperature for 15 minutes. The Bunsen valve described by Campbell was used. The vial was allowed to cool to room temperature and the contents were poured into a Syracuse dish. The sacs had not dissolved and were still attached to the last abdominal sclerite which had become colorless. The yellow contents of the sac had become black, or in some cases gray if some of the material had dissolved out. The sacs were then passed from higher to lower percentages of alcohols and finally washed

in water. During this process much more of the black material had dissolved in the alcohol, although some remained. The sacs sometimes became brownish.

When a drop of 3 per cent acetic acid was placed on these reservoirs and the abdominal sclerites, the sclerites dissolved almost immediately, leaving the sacs intact. On adding a drop of 1 per cent H_2SO_4, a white precipitate, chitosan sulphate, appeared where the sclerite had gone into solution. Thus the abdominal sclerite gave the test for chitin while the reservoirs did not. When a drop of .2 per cent iodine in KI solution was added to other pairs of reservoirs, the last abdominal segment became brown while the sacs were generally unaffected. On adding a drop of 1 per cent H_2SO_4 the brown segment became a deep reddish violet, the sacs still remaining unaffected. Occasionally a weak positive test was obtained from the sacs. Repeated tests gave the same results.

It was thought that possibly the contents of the sacs reacted with the membranous reservoirs to form some substance which would not give or interfered with the typical test for chitin. Therefore the abdominal sacs were dissected out, punctured, and placed in ether in order to dissolve away their contents. This could in no way interfere with the test, as chitin is insoluble in ether (Wigglesworth, 1939). The ether treated sacs were then subjected to the chitin tests. After the alkali treatment, the sacs were partly dissolved in 3 per cent acetic acid while their abdominal sclerites dissolved completely, and the characteristic precipitate of chitosan sulphate was obtained on adding a drop of 1 per cent H_2SO_4. However, the sacs gave an excellent positive test with the iodine-dilute acid, becoming a deep reddish violet in a drop of that solution.

The abdominal reservoirs of Stage III pupae (those shortly to emerge) and newly emerged adults were also subjected to the chitin tests. In these animals, the sacs are already present but are collapsed and wrinkled and as yet contain no fluid. Therefore the chitin test can not be influenced by the secretion. These reservoirs gave clear cut positive tests for chitin. Thus it is very probable that the failure to get a characteristic test for chitin when the entire turgid sacs plus their contents are treated is due to the interference of the secretion itself. From these various tests we may conclude that the membranous reservoirs are probably continuations of the exocuticle and are chitinous. Wigglesworth (1934), citing Weber, states that the odoriferous glands are nearly always lined with a delicate membrane continuous with the epicuticle. If we consider the reservoir as the lining of the odoriferous glands in Tribolium then we have an exception to the above observation.

Measurements were taken of full turgid reservoirs which were dissected away in distilled water. Only animals with turgid reservoirs were measured, these individuals being taken about two months after emergence (at 27° C.). The length of the sac was measured from the projections of the lateral margins of the last abdominal sclerite (Pl. I, fig. 3, LP) (ventral side up) to the apex of the reservoir. The width of the reservoir was taken at its widest point. The average length of turgid abdominal reservoirs of 15 individuals was 675 mu. with a width of 329 mu.

It was found that the entire exoskeleton of the adult is resistant to the KOH treatment. Since the cuticula becomes colorless and transparent after the strong alkali treatment, and the sacs become black, an excellent method is present for demonstrating these reservoirs in their normal position within the body. Treating the animals in a 50–80 per cent KOH solution heated to 140°–150° C. for one half hour or more was better than heating to 160° C. in a saturated solution since there was less disruption of the sacs. Removing the elytra and wings and puncturing the dorsal cuticula also helped, for it gave the body tissues an opportunity to dissolve out without stretching and distorting the animal (Pl. II, figs. 9–13, 15, 16). Actually within the body, the sacs are longer and slightly narrower. Animals which were cleared in hot KOH leaving the reservoirs clearly standing out showed that the turgid sacs may extend farther than the upper margin of the last three

EXPLANATION OF PLATE I

FIG. 1. The abdominal reservoirs (R) of an adult four days after emergence. The sacs are collapsed due to the fact that they are only partly filled with the secretion (S). The digestive and reproductive tracts have been dissected away.

FIG. 2. The abdominal reservoirs of an adult about two weeks after emergence, showing the turgid sacs full of secretion.

FIG. 3. Turgid abdominal reservoirs showing the effect of puncturing the left sac. Some of the secretion has flowed out and the membranous wall has collapsed.

FIG. 4. Turgid abdominal reservoirs after concentrated H_2SO_4 has been drawn under the cover slip. The acid has already reached the right sac causing almost all of the yellow contents to turn red. A small area is still unaffected. The membranous wall of the reservoir does not dissolve. The left sac is still yellow since it has not yet been reached by the acid.

FIG. 5. The abdominal reservoirs of *Gnathoceros cornutus*. The secretion is found in the rounded apical region of the sac, and the reservoirs, even though not completely filled with fluid, are not collapsed. The digestive and reproductive tracts have been dissected away.

FIG. 6. The abdominal reservoirs of Gnathoceros (under compression of a cover slip) showing the striated structure of the sacs, and the long thin crystals (C) which may be present with or without the yellow secretion.

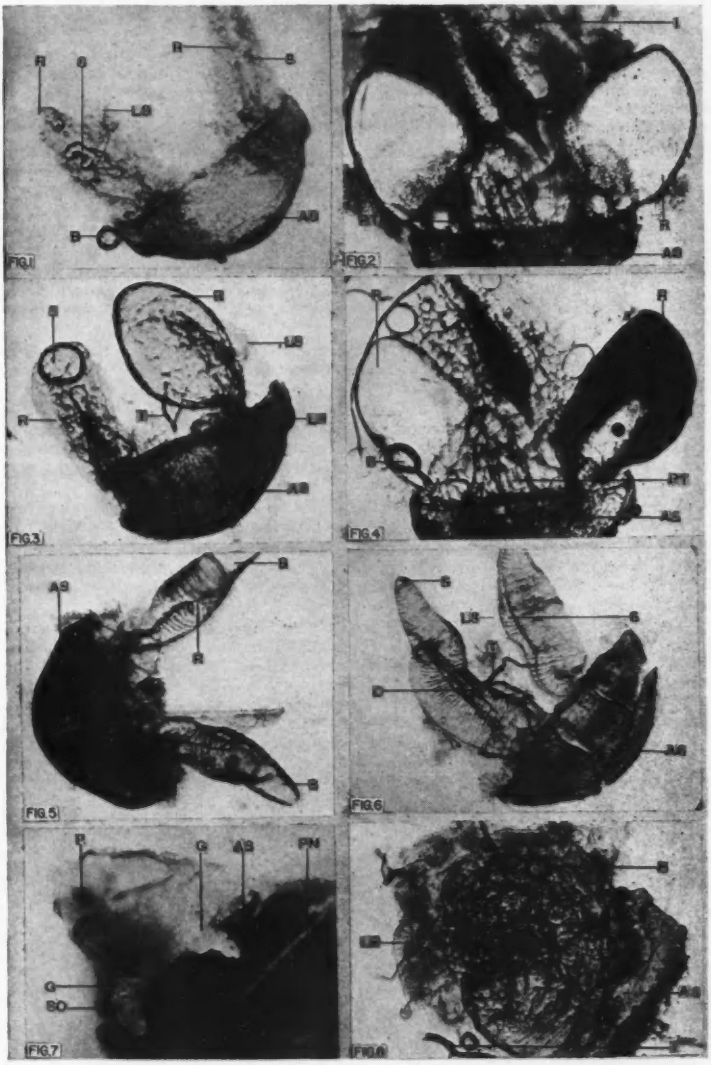
FIG. 7. The evertible repugnatorial glands (G) of *Tenebrio molitor* shown being extruded (by pressure of a pin (PN) on the abdominal sclerites) over the last abdominal sclerite. The secretion, which is exposed to the air, gives the gland the glossy, fleshy appearance. The small black specks are the solid material (SO) which cling to the sacs when everted.

FIG. 8. One of the evertible glands of Tenebrio, showing the secreting aggregates of cells (LS) and the somewhat round shape of the retracted gland. The dark material is the solid.

EXPLANATION OF ABBREVIATIONS

AS—last abdominal sclerite
B—air bubble.
C—crystals
G—everted gland
I—intestine
LS—secreting cells
LP—lateral projection of last abdominal sclerite
P—penis
PN—pin pressing down on abdominal sclerite
R—reservoir
RT—reproductive tract
S—secretion
SO—solid matter in sac
T—tracheae

For figs 1–6 and 8, all specimens were dissected out and photographed in distilled water. Figs. 1–4, actual width of last abdominal sclerite, 700 mu.


R
G
R
S
LG
AG
D
FIG.1
A
T
R
AG
FIG.2
G
S
LG
R
D
LG
AG
FIG.3
R
R
D
PT
AG
FIG.4
AG
G
R
S
FIG.5
S
LG
G
D
AG
FIG.6
R
G
AG
PN
G
SO
FIG.7
S
LG
AG
FIG.8

EXPLANATION OF PLATE II

FIG. 9. Newly emerged adult. Although the sacs are already formed, (the abdominal ones (AR) can be faintly seen) there is no blackening because the secretion has not yet been formed. The thoracic sacs give a positive reaction for the presence of the secretion (with KI starch paper) at emergence, but no doubt the amount is so small that it is dissolved out during the alkali treatment.

FIG. 10. An adult ten days after emergence (fed on wholewheat flour at 27° C.), showing the thoracic sacs already turgid with secretion while the abdominal ones have not yet expanded to their fullest capacity.

FIG. 11. An adult fifteen days after emergence (fed on wholewheat flour at 27° C.), showing the expanded reservoirs. The left abdominal sac already extends to the upper margin of the third abdominal sclerite. The right sac did not contain as much secretion and therefore is smaller than the left one.

FIG. 12. An adult that has been starved for eight days, showing turgid sacs, indicating that food is unnecessary, in the adult stage, for the initial production of the secretion.

FIG. 13. An adult starved for thirteen days, showing the comparatively small amount of secretion in the sacs, as compared with the eight-day starved adult.

FIG. 14. A newly emerged adult (still white and soft) which has been disturbed on acidulated KI starch paper. The secretion is given off from the thoracic sacs only and the vapors discolor the paper around the head. (The darkened areas along the abdomen are due to the shadow of the beetle. The light was coming from the right.)

FIG. 15. Head and thorax (ventral view) of an adult about two months after emergence, showing the huge size which the thoracic reservoirs may attain.

FIG. 16. The abdomen of an adult about two months after emergence, showing the large reservoirs which reach more than half way across the second abdominal sclerite and take up almost the entire width of the last three abdominal segments.

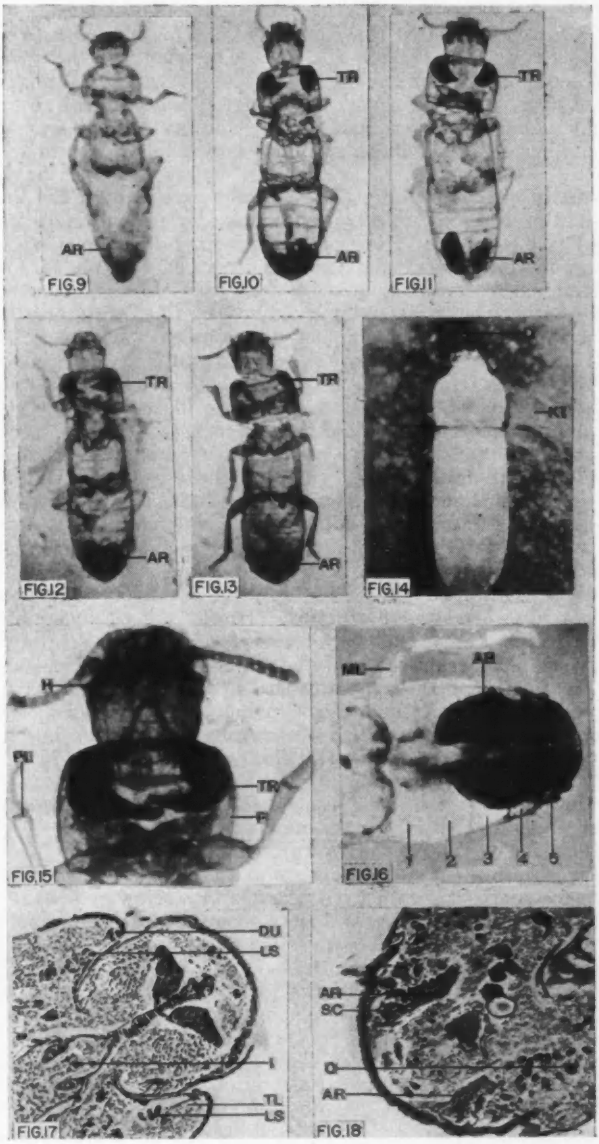
FIG. 17. Frontal section through a newly emerged adult showing the small ducts (DU) leading to the opening in the rounded front angle of the prothorax. The sacs are already slightly expanded and a lumen is present indicating the presence of secretion (dissolved away). Secretory cells are seen, and note that the opening is at about the same level as the digestive tract. (Fixed in Dietrich's solution, stained with Delafield's Haematoxylin and Eosin, and cut at 8 mu.).

FIG. 18. Frontal section through the abdominal region of the same animal as in fig. 17. The reservoirs are collapsed and the absence of a lumen probably indicates the absence of secretion at this time. Individual secreting cells may be seen closely adpressed to the sacs.

EXPLANATION OF ABBREVIATIONS

AR—abdominal reservoir
D—discoloration of starch paper due to secretion
DU—duct
H—head
I—digestive tract
KI—acidulated KI starch paper
LS—secreting cells
ML—metathoracic leg
O—oenocytes
P—prothorax
PL—prothoracic leg
SC—individual secreting cells
TL—lumen in the thoracic reservoir
TR—thoracic reservoir
1, 2, 3, 4, 5—first, second, third, fourth, and fifth abdominal sclerites respectively.

For figures 9–13 and 15–16 the specimens were treated with 80 per cent KOH at 140° C. for about one-half hour. Actual size of adult, 4 mm. long.


AR
FIG.9
TR
AR
FIGJO
TR
AR
FIGJ1
TR
AR
FIGJ2
TR
AR
FIG.13
KI
FIG.14
H
PR
TR
P
FIG.15
ML
AR
1
2
3
4
5
FIGJ6
DU
LS
I
TL
LS
FIG.17
AR
SC
O
AR
FIG.18

abdominal sclerites and may measure 825 mu. in length. Measurements were still taken from the projections of the lateral margins even though it was found that the sac may sometimes extend slightly below this point (Pl. II, fig. 13, AR). The length of the abdominal sacs of individuals prepared in this manner averaged 710 mu. with a width of about 300 mu. From Pl. II, fig. 16, one can see that turgid sacs may take up more than half the width and extend half way or more down the length of the abdomen. The sacs follow the contour of the body.

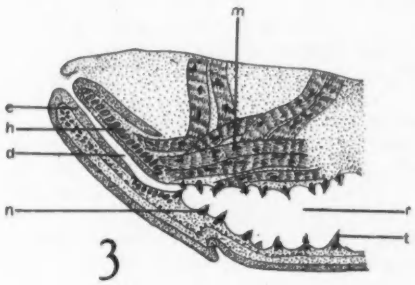
In newly emerged adults the reservoirs extend over the last two abdominal sclerites but are collapsed, wrinkled, and contain no secretion (Pl. II, figs. 9, 18, AR). However, the sacs are fully formed long before they become completely expanded with secretion. Fig. 1 (Pl. I) shows the abdominal reservoirs of an adult four days after emergence. They are fully formed, but collapsed and only partly filled with secretion (s). In some individuals the abdominal reservoirs may be practically full in 7–10 days after emergence and are generally full in two or three weeks (Pl. I, fig. 2; Pl. II, fig. 11). In general both sacs contain about the same amount of secretion. However, some individuals are found in which one sac contains more fluid than the other (Pl. II, fig. 11).

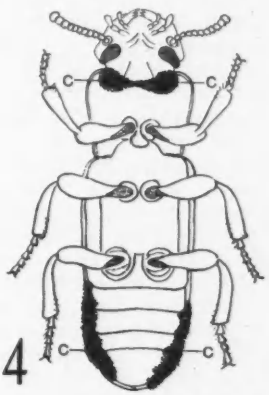
The reservoirs collapse very easily and if punctured (Pl. I, fig. 3) liberate the oily fluid as large globules which generally float to the surface of the medium (distilled water) and burst into many small oily droplets. The fluid is very adhesive and will cling to a dissecting needle when removed from the sac. Under higher magnification, the yellowish oil can generally be seen as large and small globules which move about within the sac. The sac itself is cellophane-like without any apparent visible cellular structure. However, if vitally stained with methylene blue many small hypodermal nuclei appear scattered over the surface. Also scattered over the surface are many small wrinkles (Text Fig. 6, w), and these are arranged in definite groups or patterns, each group radiating from a single point. The nuclei and wrinkles probably denote the places where the membrane is thrown into bristles on the inner surface of the sac. (This will be described later under development of the reservoirs.)

Sections through the abdomens of adults two to three weeks after emergence show that the abdominal reservoirs possess a closing mechanism. The reservoir narrows down to a long duct (Text Fig. 3, d) which is lined by a continuation of the amber colored epicuticle. The upper surface of the duct is thickened, has a row or rows of hypodermal nuclei (Text Fig. 3, h) and has a group of muscles running into it (Text Fig. 3, m). When these muscles are relaxed, the opening to the reservoir is closed. When contracted, the muscles lift the upper surface of the duct away from the lower one, thus opening up the reservoir and allowing the fluid to vaporize and escape. These muscles follow and lie close to the surface of the reservoir (Text Fig. 3) and upon contraction would not only open the duct but would even depress the sac thus aiding in forcing out the secretion. The closing mechanism is so efficient that artificial pressure applied with a needle and strong enough to break the dorsal abdominal wall may not force out the secretion from the abdominal reservoirs.

The Thoracic Reservoirs.—The reservoirs of the thoracic glands are more difficult to observe because both the dorsal and ventral surfaces of the thorax are melanized. When full of secretion they may be as large as turgid abdominal sacs. Using a binocular microscope with dark field and transmitted light, the thoracic sacs may be seen from the ventral surface in the living animal as half-moon shaped structures slightly darker than the chitin. With reflected light the sacs appear somewhat transparent through the thoracic cuticle. This pertains to animals whose reservoirs are full of secretion.

By removing the head and abdomen, and then picking away the thoracic cuticle with dissecting needles, the reservoir and glandular cells may be freed. The thoracic reservoirs, like the abdominal pair,





Text Figure 3. A semi-schematic drawing of a longitudinal section through the abdomen of an adult about two weeks after emergence, showing the closing mechanism of the abdominal reservoirs. d—duct, e—epicuticle, h—hypodermal cells, m—muscles, n—hypodermal nuclei, r—reservoir, t—bristle. Outlined with the aid of a camera lucida. Fixed in Dietrich's solution and stained with haematoxylin. Actual height of abdomen, 115 mu.

Text Figure 4. Diagram of an adult which has been inactivated on ice, showing the general regions where the secretion crystalizes out on the body. The stippled areas (C) on the thorax and abdomen indicate clumps of crystals.

possess numerous hypodermal nuclei and wrinkles over their surfaces. The sacs are wide near their point of attachment (dorsal) and taper down to a point at their apex. They follow the contour of the thorax and run dorso-ventrally. Adults about two months after emergence show turgid sacs which may extend more than half way down the prothorax and their apices may cross along the mid-ventral line (Pl. II, fig. 15). The thoracic sacs in general seem to fill up before the abdominal ones (Pl. II, fig. 10). However, the abdominal sacs fill up shortly afterwards and generally have a greater volume than the thoracic reservoirs.

It was difficult to get good sections through the thoracic region of older beetles as both the dorsal and ventral cuticula are heavily sclerotized. In the abdominal region, the tergum is not extensively sclerotized so that the animals may be sectioned from the dorsal to ventral surface. Thus any tearing due to the hardness of the ventral abdominal sclerites will not necessarily injure the tissue. It appears that a closing mechanism, like that found for the abdominal reservoirs, is not present for the thoracic sacs. In fact, the duct leading to the outside is so short (Pl. II, fig. 17, DU) that it is almost impossible to have a muscular closing mechanism such as that found in the abdomen. Sections show that many muscles are present in the thorax around and in the reservoir region and possibly contraction of these muscles helps force the secretion out through the openings. What is difficult to explain is the retention of the secretion within the sac even though the exit is continually open. However, from a study of sections, the opening is seen to be very minute and in life it is possible that this opening is even smaller, so that little secretion escapes except under great internal pressure.

The Openings to the Reservoirs.—When an adult Tribolium is placed in acidified KI starch solution, the beetle gives off the secretion which in turn discolors the solution. Under the binocular microscope, the secretion from the abdominal reservoirs can be seen flowing in two streams through two openings in the last abdominal pleurite, one on either side of the anal opening. These are at points on the last abdominal sclerite where the lateral margins project conspicuously (Pl. I, fig. 3, LP) and where there is an indentation immediately posterior to these projections (Text Fig. 2, arrows in abdominal region). This can be more clearly seen by substituting H_2SO_4 alone for the starch solution. This acid is more viscous than the other medium and as the beetle gives off the secretion, the solution becomes brick red immediately around the openings of the reservoirs.

The opening of the thoracic sac is found at the apex and rounded front angle of the prothorax, close to the head at about the level of the intestine (Pl. II, fig. 17, DU). There are two such openings, one for each sac, in each corner of the prothorax (Text Figs. 1 and 2, arrows in the thoracic region).

Development of the Reservoirs.—In the thoracic reservoir region of newly formed pupae, many hypodermal cells are seen, the cytoplasm of which forms long thin filaments. The cuticle is still entire, that is, the opening to the outside has not yet formed. Three to six days after pupation, the sac is already well developed and the opening to the outside is present. A small duct lined by a thick layer of hypodermal cells leads to the opening. The hypodermal cells have greatly proliferated in this region and these are almost entirely nuclear material with very little if any cytoplasm. Many of these nuclei migrate in with the reservoir membrane and these eventually lie at the points where the bristles develop. At this time small projections from the membrane indicate that these bristles are already forming. Immature bristles generally have many lightly staining lateral projections which seem to disappear from the sacs of older beetles (Text Fig. 3, t). The

nuclei at the base of the bristles also become much smaller as the sac and bristles develop. It is possible that these hypodermal cells form the bristles and as they develop they tend to push in the sac membrane thus producing the characteristic wrinkles which are present all over the surface of the reservoirs. The function of these bristles is not known but it is possible that they serve to increase the internal surface area of the sac or to check the flow of oil along the walls. In newly emerged adults the thoracic reservoir duct is lined by the amber colored epicuticle.

In sections through the reservoirs of pupae it is seen that the sacs are filled with a more or less lightly staining substance. This substance can be traced out of the openings of the sac and is found to be identical with the lightly staining material present between the pupa proper and the outer puparial membrane which is eventually shed when the adult beetle emerges. This substance may possibly be a liquid in life. In sections through the reservoirs of adult beetles the material in the sacs is dissolved out so that the reservoir is represented by the membrane which surrounds an empty non-staining area (Text Fig. 3, r).

The abdominal reservoirs may be detected at the same time as the thoracic ones and they differ in having a much longer duct leading to the outside (Text Fig. 3, d). The development is the same with a great proliferation of hypodermal cells migrating in with the reservoir membrane, and the formation of bristles.

The Glandular Secreting Cells.—There are two types of secreting cells:

1. Individual or paired cells which lie closely adpressed over the surface of the reservoir. In life, these are generally round but may be flattened on the side close to the sac. These are small cells with minute granules or larger cells filled with oil-like globules. Nuclei are observed with difficulty in the living condition. A small twisted tube can be seen in these cells, and it appears as if both ends of this cuticular tube end in the cytoplasm of the cell itself (Text Fig. 11, c). Actually, one end of the tube leads directly into the reservoir at the point of attachment of the cell. This can be clearly seen by dissolving away the cells with KOH or H_2SO_4, leaving only these tubes and the sacs (Text Fig. 12). At the free end of the tube (the portion lying in the cytoplasm of the cell) there is a slight constriction (Text Fig. 12, cn) and the canal then leads into a slightly dilated terminal portion. The paired secreting cells are actually two fused individual secreting cells (Text Fig. 11). Their cell boundaries may be visible in the living condition. These individual and paired cells are found over the surface of the abdominal sacs but are generally lacking in the apical region of the reservoir and apparently are not present on the thoracic sacs.

Whole abdominal glands were dissected out, at different periods after emergence, in distilled water, and vitally stained with methylene blue. In this way the cell outlines could be easily seen and measured. Measurements of individual secreting cells from animals ranging from 42–150 hours after emergence (a period when secretion is actively being manufactured) showed little difference in cell size. They averaged 33.5 mu. in diameter. Paired secreting cells averaged 49.1 mu. long and 33 mu. wide. During most of this period, these cells were

filled with small granules which obliterated all cell structures but the cuticular tube. In individual secreting cells of animals 150 hours after emergence, small clear areas were noted in the cytoplasm. These small areas probably coalesce, for older individual secreting cells may be seen which generally possess one huge vacuole which occupies almost the entire cell leaving only a small margin of cytoplasm. In many cases, very light radiating fibrillae converge toward the center of this vesicle. Sections through these cells in newly emerged adults show that the darkly staining cuticular tube rests in a clear cytoplasmic area. This clear region persists in the cells of older beetles (Text Fig. 11, ca).

2. The second type of cell is much more complex than the first. These occur in lobulated aggregates, each cell with its nucleus, granular cytoplasm, a large clear vacuolar area which will be called the primary vesicle (Text Fig. 5, p^1), and a smaller vacuolar area which will be

---

EXPLANATION OF TEXT FIGURES 5–13

Text Figure 5. A semi-schematic drawing of an aggregate of secretory cells showing the usual arrangement of the various structures. Actual length of lobe, 170 mu.

Text Figure 6. The tubes from an aggregate of cells which remain after treatment with KOH. The differentiation of the tube is clearly seen, and the canals run into the reservoir. Length of canal, 250 mu.

Text Figure 7. Section through a part of an aggregate of cells in the thoracic region in an early Stage I pupa, showing the groups of hypodermal cells with large nuclei and darkly staining cytoplasm. The canal containing the nucleus leads under the group of cells. Length of part of lobe, 49.5 mu.

Text Figure 8. An individual cell from an aggregate in the thoracic region of a Stage II pupa, showing the smaller nucleus, the secondary vesicle, and the hook resting in the lighter staining cytoplasm which represents the forming primary vesicle. Diameter of cell, 23.1 mu.

Text Figure 9. Section through a part of an aggregate of cells in the abdominal region of an adult three weeks after emergence, showing the difference in staining reaction of the bulb and hook. Width of cell, 33 mu.

Text Figure 10. A tube in the process of formation from the thoracic region of a Stage II pupa. The canal is already formed and leads into the sac. The nucleus is still quite large and causes the canal to bulge. The bulb has already formed and rests in the secondary vesicle. Length of canal, 56 mu.

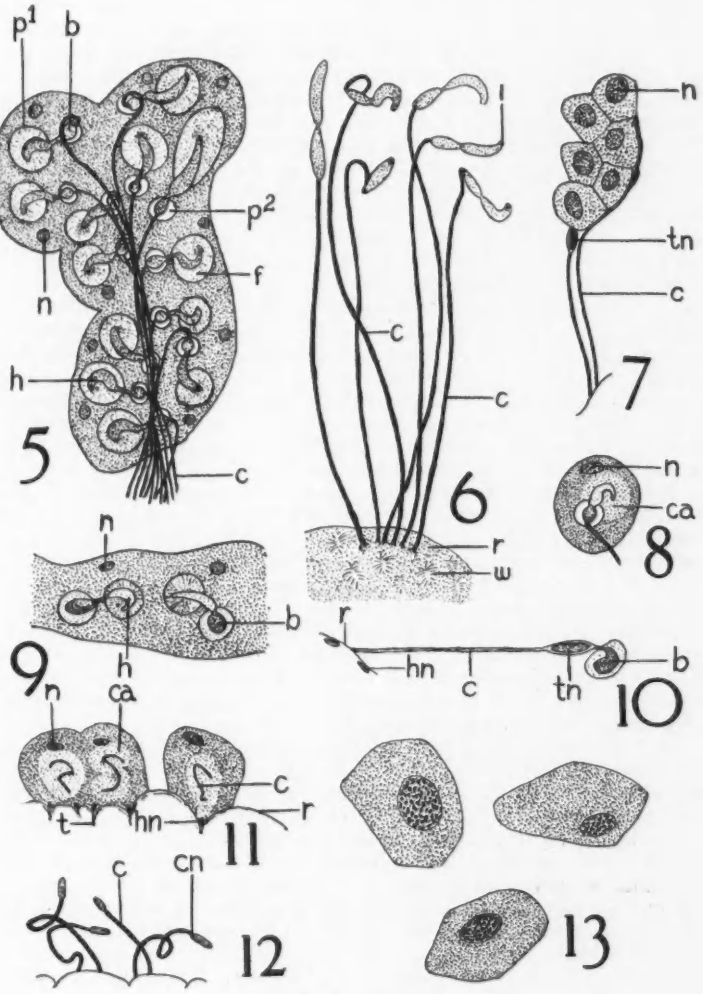
Text Figure 11. Section through an individual and paired secreting cell from the abdomen of an adult three weeks after emergence. The cells are closely adpressed to the wall of the reservoir. Size of single cell, 33 mu.

Text Figure 12. The tubes from individual and paired secreting cells which remain after KOH treatment. Length of canal, 16.5 mu.

Text Figure 13. Oenocytes of an adult three weeks after emergence, showing the darkly staining nuclei and the general shape of the cell. Size of large oenocyte, 33 mu.

EXPLANATION OF ABBREVIATIONS

b—bulb
c—canal
ca—clear area
cn—constriction
f—radiating filaments
h—hook
hn—hypodermal nuclei
l—lumen (?)
n—nucleus
p^1—primary vesicle
p^2—secondary vesicle
r—reservoir
t—bristle
tn—tube forming nucleus
w—wrinkles on surface of reservoir



TEXT FIGURES 5–13

Figures 7–11 and 13 were drawn from material fixed in Dietrich's solution and stained with Delafield's haematoxylin and eosin. All drawings were outlined with the aid of a camera lucida.

designated as the secondary vesicle (Text Fig. 5, p^2). The primary vesicle generally contains fine radiating fibrillae converging toward its center (Text Fig. 5, f). No fibrillae are noticeable in the secondary vesicle. A long thin chitinous tube runs into each cell where it is differentiated into three main structures: (a) a curved end, called the hook (Text Fig. 5, h), resting in the primary vesicle, constricting and then expanding into (b) a generally rounded structure, the bulb (Text Fig. 5, b), which in turn rests in and occupies almost all of the secondary vesicle. This bulb also constricts into (c) a long thin tube, the canal (Text Fig. 5, c), which may either twist around over the bulb or run directly and freely down the lobe of cells and enter the reservoir near its base. When these cells are dissolved away with KOH the tubes may be followed individually to their points of entrance in the sac. Each enters individually, as they do not fuse into a common duct (Text Fig. 6). In many instances frontal views of the hook showed an opening (Text Fig. 6). Whether or not this actually is a lumen is hard to say. In living cells, small granules were often seen undergoing Brownian movement within the bulb.

The canals may be more than 264 mu. long and are the only structures which connect the glands with the reservoir. The canals connecting the secretory lobes with the thoracic reservoir are smaller than the canals in the abdominal glands so that the thoracic cells lie close to the surface of the sac. The lobes are well supplied with tracheae and trachioles. The hook stains very lightly with Delafield's while the bulb takes the stain heavily (Text Fig. 9). This may possibly indicate a chemical difference between these two regions. The canal also stains more darkly than the hook. With vital staining, using methylene blue, no cell boundaries could be made out and the gland appears as a syncytium (Text Fig. 5). In sections of newly emerged and older beetles, some portions of the secretory lobe could be differentiated into individual cells by clear areas where the cells appeared to have separated. Other portions of the cytoplasm run together without being separated by these areas and no cell walls were seen.

It is difficult to get an accurate measurement of the size of the lobulated aggregates, as these may be curved. There may be a great deal of variation in the number and size of the original individual cells that make up a gland and therefore the size of the gland will vary. The cells may be arranged in a circle or in a single or double row. Some measurements of vitally stained glands may be noted in order to give some idea of their relative sizes. One aggregate consisting of a double row of cells was 375 mu. long and 100 mu. wide. Another gland of 6 cells arranged in a single row was 161.7 mu. long and 49.5 mu. wide. A circular gland of cells had a diameter of 92.4 mu. The size of the primary vesicle may vary in a secretory lobe, some being slightly smaller than others, depending on the size of the original cell it is in. There was little difference in the size of this vesicle during the period 42–138 hours after emergence, the average diameter being 25.2 mu. These glands are present in both the thoracic and abdominal regions.

Thus from this description we can see that actually the lobe consists of many individual glands. The cytoplasm produces the odoriferous

substance which probably collects in the primary vesicle where it is conducted through the hook, bulb and canal and then finally stored in the reservoir. The function, if any, of the various parts such as hook, bulb, and secondary vesicle is not known.

Origin and Development of the Secreting Cells.—The development of the glandular cells was followed in both the thoracic and abdominal regions. The following description is based on observation of sections through the thorax of various pupal stages. In newly pupated animals, the secretory cells could not be detected. In sections of pupae with lightly pigmented eyes (3–6 days after pupation) groups of cells which apparently had broken loose from the hypodermis and migrated inward could be seen. These hypodermal cells contained large nuclei which occupied most of the darkly staining cytoplasm (Text Fig. 7). The tubes were also partly formed and many could be seen with large elongated nuclei which caused the straight canal portion to bulge (Text Figs. 7, 10, tn). At this time the canal has already entered the reservoir. These tube-forming cells are generally found close to or sometimes among the groups of hypodermal cells that are developing into the lobe (Text Fig. 7, tn). Apparently certain hypodermal cells produce the tubes. The cytoplasm from one end of these tube-forming cells develops into the long canal which eventually enters the sac while the opposite end of the cytoplasm differentiates into the bulb and hook which rest in their respective vesicles (Text Fig. 10). This differentiation into bulb and hook may take place before the vesicles are formed and therefore before the cells have matured. As the tube develops, its nucleus becomes smaller and as a result the bulge in the canal decreases and eventually disappears (cf. Text Figs. 7 and 10, tn).

When the eyes of the pupae are darkly pigmented (end of Stage I, about seven days after pupation) the bulb and hook are already formed and the secondary vesicle is clearly marked off by a membrane. The bulb rests in the secondary vesicle. The primary vesicle is not yet marked off by a membrane and is represented by a lightly staining cytoplasmic area in which the hook rests. The nuclei of the cells are still large and individual cell boundaries can still be made out.

During Stage II (about eight days after pupation) the cells are essentially the same as in the previous stage except that the cells are larger and the nuclei smaller while the clear area (the future primary vesicle) has become more distinct (Text Fig. 8, ca). Nuclei can still be seen in the tubes but these nuclei are smaller.

By Stage III (about nine days after pupation and shortly before emergence) the gland cells are fully formed and differ from those in the adult beetles in being much smaller in size and still possessing individual cell walls. A membrane now surrounds the primary vesicle and the radiating fibrillae can be seen converging toward its center. Evidently these cells in the thorax may already function at this time since secretion has been detected in a number of Stage III pupae (see Table I). Some of the canals, in animals at emergence, still contained nuclei which had become so small that the original bulge in the canal was absent. These nuclei eventually disappear.

The lobes of secretory cells in the abdomen develop in the same

manner and apparently at the same rate as those in the thorax. At emergence the abdominal glands appear as fully developed as the thoracic ones, even though the secretion can be detected in the thorax earlier than in the abdomen (see Table I).

Individual secreting cells apparently are not found on the thoracic reservoirs but are present on the abdominal ones only. These come from hypodermal cells which migrate in and become adpressed to the sac wall (Pl. II, fig. 18, sc). By Stage II these cells have fully formed canals but the clear area in which they rest is not very prominent. Whether the canal forms from the hypodermal cell which develops into the individual secreting cell or whether it is made from another hypodermal cell which is already along the reservoir wall could not be determined.

These individual secreting cells look much like some of the oenocytes which are very numerous around this region, in the newly emerged adult. However, they are not to be mistaken for them since oenocytes never possess a canal or a clear area but have a darkly staining nucleus which appears to have many nucleoli, and a more or less uniformly staining cytoplasm (Text Fig. 13). Also the oenocytes are seldom round and are distributed all over the body, either singly along the sides of the abdomen or in groups among the fat cells (Pl. II, fig. 18, o). They show a definite cycle in size, shape, and numbers, and from sections of pupae appear to arise from hypodermal cells also. Wigglesworth (1933) found that the oenocytes arise from epidermal cells in Rhodnius, and Snodgrass (1935) states that the oenocytes are epidermal cells which have migrated into the body.

McIndoo (1914) found that the scent glands of the honey bee also arise from migrating epidermal cells. He also observed that certain hypodermal cells form the chitinous tube and that as these tubes or long processes develop, the cytoplasm and nuclei of the cells diminish in size. He concludes that the hypodermal cell must serve as a storeroom for building a tube. Apparently this is also true for the development of the tube in the secretory lobes in Tribolium. However, the process is probably more complex since the tube is not a straight canal, as in the bee, but differentiates into a hook and bulb which rest in the cell. The nuclei of the cells forming the secretory lobes becomes smaller as the cells mature. Since the vesicles and their membranes are not present in the early developmental stages of these cells, it is possible that the nuclei contribute some material to their formation and as a result decrease in size.

Gilson (1889) in discussing the morphological significance of the various parts of the odoriferous gland cells in ***Blaps mortisaga***, states that the membrane of the vesicle, of the ampulla (a dilation at the end of the tube), and of the tube are analogous to the nuclear membrane and to other productions which arise in the cell by a condensation of the protoplasmic reticulum. The radiating filaments are nothing but radial fibres of the reticulum, which have become more regular and stronger.

McIndoo found that at emergence the gland cells seem to be perfectly developed in all respects, except that they are only about two-thirds

the size of the gland cells in older bees. He suggests that the rapid growth which takes place in these cells after emergence may be due to the fact that the gland cells suddenly begin to function. The increase in size of the glandular cells in Tribolium after emergence may also possibly be due to such an increase in activity. But it should be remembered that at emergence, secretion is detected in the thoracic glands only which would indicate that the thoracic glands are more active than the abdominal ones. Actually no difference in size or structure could be detected histologically. However, though secretion is detected in the thorax first, the amount present may be very minute and the actual difference in secretory activity between the cells in these two regions may be so slight as to be difficult to detect.

A POSSIBLE MECHANISM FOR THE MODE OF EJECTION OF THE ODORIFEROUS SUBSTANCE

From a description of the glands and from certain observations on the emission of the secretion, we may suggest a possible mechanism of ejection of the fluid from the reservoirs. The structure of the glands may be briefly summarized as follows. They consist of large reservoirs which are merely continuations of the exocuticle of the beetle. These reservoirs are easily collapsible and therefore are constantly subjected to changes in body pressures. A mechanism controlled by muscles is present for closing the opening to the outside of the abdominal reservoirs. When relaxed, these muscles keep the exit closed and when contracted keep it open. These muscles also lie dorsally, closely adpressed to the surface of the reservoir. When contracted they may have something to do with forcing out the secretion. The thoracic sacs appear to lack a closing mechanism, but muscles surround the reservoirs and their contraction would force out the secretion. The glandular secreting cells have nothing to do with the ejection of the secretion but merely produce the substance which flows through the cuticular tubes and fills the sacs where it is stored.

Some Observations on the Ejection of the Secretion.—1. The thoracic glands may eject independently of the abdominals and vice versa. In many animals, the secretion appears to be given off from the thoracic sacs more readily than from the abdominal ones. This could be explained by the absence of a closing mechanism for the thoracic reservoirs. However, animals have also been seen which give off the secretion readily from both the thorax and abdomen.

2. If adults are placed in a Petri dish which is kept on ice cubes contained in a finger bowl, it will be seen that they are inactivated in a few seconds and while being inactivated they give off the secretion. Generally after a slight delay, the substance is given off in such quantities that it can easily be seen, under the binocular microscope, coming from the four reservoirs. Usually the material first comes from the thoracic sacs, flows out and crystallizes around the neck and down the ventral part of the head and often flattens the antennae down against the head. The fluid from the abdominal sacs flows out and crystallizes along the sides of the body or in clumps at or near the openings of the reservoirs (Text Fig. 4, c). If these inactivated animals are placed

on acidulated KI starch papers (still kept on ice) they may continue to discolor them for more than an hour. This would give one the impression that there is a continual emission from the sacs even when the animal is inactive because of the low temperature. However, the continued discoloration of the starch paper is due to the crystals which have sublimed on the body of the beetle. If these crystals are removed with needles, they (the crystals) will continue to discolor the starch paper until completely vaporized, while inactivated beetles whose crystals have been removed discolor the test paper only slightly and the discoloring soon ceases entirely. Further evidence for a cessation of secretion soon after the initial ejection is found in the fact that only a limited amount of crystals pile up and these do not increase on the body of the animal, whereas if ejection were continuous for one hour or longer, much more of the fluid would collect. Thus when the adults are inactivated on ice, following a slight delay, there is a spasmodic ejaculation which gradually ceases.

No doubt, in nature, when Tribolium is disturbed the reservoirs are opened very slightly so that the amount of fluid given off is very small and vaporizes almost immediately. When adults are held on KI starch paper discoloration is noted but no fluid can be seen coming out of the openings. In other words, the vapors from the secretion discolor the paper. However, when placed on ice as described above, so much fluid is given off that it can be clearly seen coming out of the body. Doubtless the muscles controlling the exits from the abdominal reservoirs suddenly contract strongly, because of the low temperature, open up the sacs, and allow the fluid to escape in quantities much greater than would occur normally. Similarly, contraction of muscles in the thorax would force the secretion out of the reservoirs in this part of the body. It should be remembered that the sacs are continually under the influence of body pressure and if the exits were open, an increase in this pressure would force out the fluid.

After a very short while, ejaculation ceases. Three possible explanations suggest themselves for this cessation. The first is that all of the fluid is given off leaving the sacs empty. However, the sacs may still be full of oil. The second is that the oil crystallizes within the sacs themselves at the same time that the fluid crystallizes out on the body, thus preventing outflow. Evidence is against this, for after ejection has ceased it can be seen that the oil is still in a liquid state. This may be due to the fact that the body temperature of the beetle is higher than that of its surroundings. Wigglesworth (1939) states that although the body temperature of insects is generally the same as that of its surroundings, due to the balance of heat loss by metabolic production, this applies only over a moderate temperature range. Evaporation is the main factor in loss of heat, and therefore any factor which will affect evaporation will influence the body temperature. At low temperatures, evaporation is depressed and the body temperature may be greater than the outer environment. Himmer (1932) found that the body temperature of certain Hymenoptera may exceed the surrounding temperature. He measured an excess from as little as 3.08° C. (in Polistes) to as much as 13.73° C. (in male Apis). Thus

the body temperature of the inactivated Tribolium adults may not be low enough to cause the secretion to crystallize out within the animal.

The last and probable explanation for cessation is that the muscles controlling the openings to the abdominal reservoirs slowly but finally relax, thus closing the exit and preventing the fluid from escaping. Relaxation of the muscles would also release the pressure on both the thoracic and abdominal reservoirs.

3. It is quite possible also that the respiratory movements of the abdomen have something to do with the emission of the secretion. In Tribolium adults these movements consist almost entirely of a dorso-ventral flattening of the abdomen accomplished by means of lateral tergosternal muscles. The sterna are firm and convex while the terga are mobile and rise and fall with each inspiration and expiration. Undisturbed Tribolium adults show very slight respiratory movements and generally move very little. However, when irritated by stroking, low or high temperatures, light, etc., they become very active and their respiratory movements increase greatly, possibly because of a stimulation of the respiratory centers. Stahn (1928) believes that any stimulus will cause an increase in respiration in insects. There also seem to be some slight longitudinal telescopic movements of the abdominal segments shortly before emission of the gas, and most of this movement is confined to the last three abdominal segments and the last abdominal sclerite often bends downward. Undoubtedly all these movements tend to increase the blood pressure of the beetle, which in turn would tend to constrict the collapsible reservoirs. Abdominal movements would also influence the thoracic sacs since any increase in abdominal pressure would be transmitted through the haemolymph and affect the thoracic reservoirs. However, it is necessary for the abdominal sac to be opened by the contraction of the duct muscle before any secretion is emitted. Thus it is possible for the beetle to increase the body pressure by these various abdominal movements, and still not give off any secretion, a phenomenon which was often observed.

THE KI STARCH TEST AS AN INDICATOR FOR THE PRESENCE OF ODORIFEROUS GLANDS

It is quite possible that many of the odoriferous substances given off by insects are oxidizing agents and will discolor acidulated KI starch paper. If this is so then we have a very simple method for determining the presence of such secretions, for merely holding an insect on this paper will show immediately whether or not such a substance is present. However, the failure to discolor this test paper does not necessarily mean that such glands are absent. It is suggested that other insects be tested with this indicator.

Other species related to Tribolium were examined in this manner for the presence of odoriferous glands. *Gnathoceros cornutus*[5] was found to have two large abdominal reservoirs (Pl. I, fig. 5) attached to

[5]The author wishes to thank Dr. T. H. Park, of the University of Chicago, for a culture of Gnathoceros, and the American Museum of Natural History, and Miss Ethel Poris, of Washington Square College, for a supply of Tenebrio.

the last abdominal sclerite and opening laterally on either side of the anus. These sacs are striated, elongated, tapering and round at the apex, and narrow down to a small neck at the point of attachment. The striated appearance is quite similar to tracheal rings. The secretion which gives the oxidizing test on KI starch paper, may be in the form of a yellow oil which often lies at the rounded apex of the sac (Pl. I, fig. 5, s). At other times long thin yellow crystals are seen in the reservoirs (Pl. I, fig. 6, c), either with or without the oily fluid. The presence of crystals in the sacs is not unknown. Gilson (1889) found in *Blaps mortisaga* that the secretion is an oil in which swims a considerable number of crystalline yellow needles. Unlike the Tribolium reservoirs, the Gnathoceros sacs may be in an expanded state even though they are not filled with secretion. This is probably due to the fact that it is a striated structure (Pl. I, fig. 6).

The adults of both sexes of *Tenebrio molitor*[5] also possess a pair of glands whose secretion discolors KI starch paper. These are two eversible repugnatorial glands, noted by Valentine (1931), which are attached to the last abdominal sclerite. These organs consist of glandular secreting cells and an evaginable membrane which has a sac-like, tapering, appearance when everted. This structure is a continuation of the pleural membrane of the last abdominal segment. When everted the organ has a glossy, fleshy, appearance (Pl. I, fig. 7). Actually it is a very thin membranous structure about 2 mu. thick. A black, apparently non-crystalline, solid substance clings to the exposed surface of the membrane, when everted (Pl. I, fig. 7, so), and most of it adheres to the sac wall when that structure is withdrawn.

Everted (by pressure of a needle on the abdominal sclerites), the sacs may measure 800 mu. long and 400 mu. wide near the point of attachment (there is a slight difference in size of males and females). In their retracted state these same structures average 560 mu. long and 750 mu. wide. When withdrawn, the membrane is folded into two more or less rounded structures (Pl. I, fig. 8) which usually do not extend farther than the upper margin of the last abdominal sclerite. In this condition the lobes of secretory cells are found over the surface of the membrane and many minute tubes lead from these cells to the membrane. This can be clearly seen when the glands are dissected out in distilled water and vitally stained with methylene blue. Tracheae ramify over the cells and may serve to hold these lobes in place.

The membrane is insoluble in concentrated H_2SO_4. The last abdominal segment plus the evertible membrane was dissected out and subjected to the chitin tests described for Tribolium. The membrane gave excellent tests for both chitosan sulphate and the deep reddish violet color with the iodine-dilute acid solution, after being subjected to the alkali treatment.

A more detailed study of the odoriferous glands of Gnathoceros and Tenebrio is being undertaken.

---

[5]See footnote p. 419.

DISCUSSION

Dimmock (1883), Packard (1896), and McIndoo (1914) give extensive bibliographies on the odoriferous glands in insects.

McIndoo divides the scent producing organs into five types, based on their devices for disseminating the odor and for storing the secretion, as follows:

1. No special device for disseminating the odor or storing the secretion.
2. Gland cells associated with hairs and scales as a means of scattering the odor more effectively.
3. "Evaginable" sacs lined with hairs connected with gland cells as a device for storing and distributing the odor.
4. Articular membranes serving as pouches for storing and preventing a too rapid evaporation of the secretion.
5. Specialized tubes and sacs acting as reservoirs for storing and discharging the secretion.

The author gives numerous examples for each type. The glands in Tribolium and Gnathoceros obviously belong to division 5, while those of Tenebrio to type 3. McIndoo states that the organs belonging to the first four types are probably used for alluring purposes and as a means of recognition, while the fifth type is probably only used as a means of defense. However, Valentine (1931), in writing of the musky odor given off by the odoriferous glands of Tenebrio (type 3), states that it is probably merely an offensive emanation useful as a means of protection.

Tribolium confusum is often heavily infested with mites, the most common species being *Acarophenax tribolii*. The author has seen numerous mites, generally clinging to the ventral surface of the thorax and abdomen. Apparently the odoriferous glands offer no protection from these parasites. Washburn (1904) has reported the adult cadelle, *Tenebroides mauritanicus* L., as eating flour beetle larvae and adults, while Back and Cotton (1926) found that adults of Tenebroides will attack and devour the larvae of almost any insect they encounter. However, further experiments indicated that cadelle larvae are not usually predacious, and Good (1936) states that "cadelle larvae showed no tendency to attack larvae, pupae, or adults of Tribolium." Good also found the predacious *Xylocoris cursitans* (Hemiptera) attacking small larvae of *Tribolium confusum*. Except for mites, it seems from available data that Tribolium adults are seldom, if at all, attacked by other insects.

Some interesting observations have been reported regarding the mixing of Tribolium with other species. Good (1936) states, ". . . it has frequently been observed that in cases where Tribolium and other species of insects are present in the same breeding jar the Tribolium will soon crowd out the other insects. Whether this is due to the killing of other insects or mechanical crowding is a matter of conjecture." Park (1939) reports that ". . . in mixed populations, Tribolium appears to drive out Trogoderma irrespective of initial densities." In a personal communication Park (1940) writes, "I

rather imagine that although you will discover some population effects that can be correlated with the scent it will not prove to be the only or most important factor. In our mixed population studies we completely renewed the medium every 30 days. This, of course, would prevent any odor from accumulating to any great extent. . . . Tribolium does not always drive out Gnathoceros. There are instances when the latter is the winner, also Trogoderma is always driven out after a varying interval of time by either Tribolium or Gnathoceros. (It will be recalled that Gnathoceros has a pair of well developed odoriferous glands.)[6] . . . It is quite possible that the scent will prove to be a partial explanatory factor."

Chapman (1928) observed that irrespective of initial population density, eventually an equilibrium is attained after which the Tribolium population becomes relatively constant. It is known, too, that unless the medium is changed regularly, Tribolium cultures will decline and eventually die out. Park (1936) suggests that self-conditioning of the environment by the beetles is a factor which contributes to the decline of their populations, considerably before the culture reaches a decadent state. It is very possible that the secretion given off by Tribolium adults may have some influence on making for a static population and for eventually causing a decline in their numbers. If this is true, it is interesting to note that here is a case where an insect has a so-called protective device which in the long run may prove to be detrimental to the species itself.

As early as 1826, Dufour described the odoriferous glands of some Carabidae which, though much simpler than those of Tribolium, possess secretory cells with conducting tubes, and a reservoir. Leidy (1849), writing of invertebrate odoriferous glands, says: "Although varying in the degree of their complexity in different animals, and in the character of their secretion, yet the essential structure is the same throughout. Consisting of tubes or follicles of basement membrane, their complexity depends upon their greater or lesser length, their being simple or compound, straight or more or less convoluted, and isolated or aggregated in connection with the mode of supplying to them their nutritive fluid."

Cells with structural differentiations somewhat similar to those in Tribolium have been found in Brachinus (Karsten, 1848), (Dufour, 1826), *Blaps mortisaga* (Gilson, 1889), Belostoma (Dahlgren and Kepner, 1908), and in Forficulidae (Vosseler, 1890). However, these are not as complex as those in Tribolium. The secretory cells of Blaps come closest to the structure described in this paper, yet Blaps possesses only one vesicle and its chitinous tube merely dilates at the end. Gilson states that the odoriferous cell of Blaps represents the most complex type of unicellular gland and one of the most complicated forms of living cell. The odoriferous cells of Tribolium have reached a state of even greater complexity.

What the significance of the structural differences in these cells in the various species is, one cannot say. Perhaps they represent stages in the evolution of the unicellular odoriferous gland. It is possible

[6]Words in parentheses are the author's.

that the individual and paired cells of Tribolium actually represent a stage in the development of the more complex lobe found in the same animal. However, no intermediate stages between these two vastly different cells were noted.

Lastly we come to the secretion which these glandular cells manufacture. Is the end product of the cells influenced by the various structures in the cell? Does the chemical substance produced increase in complexity with the increase in complexity of the secretory cells in the various forms? The first step in the answer to these questions must be the chemical analysis of these odoriferous substances.

SUMMARY

1. The adults of both sexes of *Tribolium confusum* Duval possess two pairs of well developed odoriferous glands, one pair in the prothorax and the other in the abdomen. Each gland consists of a chitinous reservoir, continuous with the exocuticle, in which the secretion is stored, and glandular cells which manufacture the odoriferous substance.

2. The thoracic reservoirs open to the outside at each apex and rounded front angle of the prothorax, close to the head at about the level of the intestine. The abdominal sacs open through the last abdominal pleurites on either side of the anal opening at the point on the last abdominal sclerite where the lateral margin projects conspicuously and where there is an indentation immediately to the rear of these projections.

3. The glandular cells are of two main types: (1) individual or paired cells with small cuticular tubes leading into the sac, which appear to be present on the abdominal reservoirs only and absent from the thoracic ones; (2) another type which is much more complex and consists of lobulated glands. Each gland cell contains a primary and secondary vesicle with radiating fibrillae converging in the primary vesicle. A tube which is differentiated into a hook, bulb, and canal leads from the vesicles to the reservoir. The lobe in the adult beetle is a syncytium. The gland cells arise from hypodermal cells and may be detected about three days after pupation.

4. The secretion may be detected in the thoracic glands of some very late pupae which are shortly to emerge. In newly emerged adults the secretion is present in the thorax only. The substance is definitely detected in the abdominal glands two hours after emergence. Starvation has no effect on the initial production of the secretion.

5. It is suggested that the KI starch test be used as an indicator for the presence of odoriferous glands in other insects.

BIBLIOGRAPHY

Campbell, F. L. 1929. The detection and estimation of insect chitin; and the irrelation of "chitinization" to hardness and pigmentation of the cuticula of the cockroach, *Periplaneta americana*. Ann. Ent. Soc. Amer., 22: 401–426.

Chapman, R. N. 1926. Inhibiting the process of metamorphosis in the confused flour beetle (*Tribolium confusum* Duval). Jour. Exp. Zool., 45: 293–299.

1928. Quantitative analyses of environmental factors. Ecology, 9: 111–122.

Chittenden, F. H. 1896. Insects affecting cereals and other dry vegetable foods. U. S. D. A., Div. Ent., Bull. n. s., 4: 112–131.

Dahlgren, V., and **Kepner, W.** 1908. A textbook of the principles of animal histology. pp. 400–409. New York: MacMillan and Co.

Dimmock, G. 1883. On some glands which open externally in insects. Psyche, 3: 387–401.

Dufour, L. 1826. Recherches anatomiques sur les carabiques et sur les plusieurs autres insectes Coléoptères. Annales des Sciences Naturelles, 8: 5–19.

Gilson, G. 1889. Les glandes odorifères du *Blaps mortisaga* et de quelques autre espéces. La Cellule, 5: 3–20.

1889. The odoriferous apparatus of *Blaps mortisaga*. Report of the 58th Meeting of the British Association for the Advancement of Science, pp. 727–728.

Good, N. E. 1936. The flour beetles of the genus *Tribolium*. U. S. D. A., Tech. Bull. No. 498.

Himmer, A. 1932. Die Temperaturverhältnisse bei den Sozialen Hymenopteren. Biol. Rev., 7: 224–253.

Karsten, H. 1848. Harnorgane des *Brachinus complanatus* Fab. Müller's Archiv, 5: 367–374.

Leidy, J. 1849. The odoriferous glands of invertebrates. Proc. Acad. Nat. Sci. Phila., 4: 234–236.

McIndoo, N. E. 1914. The scent producing organ of the honey bee. Proc. Acad. Nat. Sci. Phila., 66: 542–555.

Mills, H. B., and **Pepper, J. H.** 1939. The effect on humans of ingestion of the confused flour beetle. Jour. Econ. Ent., 32: 874–875.

Packard, A. S. 1895, 1896. The eversible repugnatorial scent glands of insects. Jour. N. Y. Ent. Soc., 3: 110–127 (1895,) 4: 26–32 (1896).

Park, T. 1934. Observations on the general biology of the confused flour beetle, *Tribolium confusum* Duv. Quart. Rev. Biol., 9: 36–54.

1936. Studies in population physiology. VI. The effect of differentially conditioned flour upon the fecundity and fertility of *Tribolium confusum*. Jour. Exp. Zool., 73: 393–404.

1939. Interspecific competition in experimental laboratory populations. Anat. Rec., 75: 159 (abstract).

Payne, N. M. 1925. Some effects of Tribolium on flour. Jour. Econ. Ent., 18: 737–743.

Roth, Louis M., and **Howland, Ruth.** 1941. Studies on the gaseous secretion of *Tribolium confusum* Duval. I. Abnormalities produced in *Tribolium confusum* Duval by exposure to a secretion given off by the adults. Ann. Ent. Soc. Amer., 34: 151–171.

Snodgrass, R. E. 1935. Principles of insect morphology. New York: McGraw-Hill Book Co.

Stahn, I. 1928. Regulation of respiration: Dixippus, Aeschna larva. Zool. Jahrb. Physiol., 46: 1–86.

Valentine, J. M. 1931. The olfactory sense of the adult meal worm beetle *Tenebrio molitor* (Linn.). Jour. Exp. Zool., 58: 165–229.

Vosseler, J. 1890. Die Stinkdrüsen der Forficuliden. Archiv. für Mikr. Anat., 36: 565–578.

Washburn, F. L. 1904. Injurious insects in 1904. Minn. State Ent. Ann. Rept., 9: 36–37, 43–44.

Wigglesworth, V. B. 1933. The physiology of the cuticle and of ecdysis in *Rhodnius prolixus* (Triatomidae; Hemiptera); with special reference to the function of the oenocytes and dermal glands. Quart. Jour. Micr. Sci., 76: 270–318.

1934. Insect physiology. Methuen and Co.

1939. The principles of insect physiology. Dutton and Co., Inc.

SIPHONAPTERA: SPECIES AND HOST LIST OF MONTANA FLEAS, by WILLIAM L. JELLISON, GLEN M. KOHLS, and HARLOW B. MILLS. Pages 1–22, paper bound, 6 x 8¾ inches. Misc. Pub. No. 2, MONTANA STATE BOARD OF ENTOMOLOGY, Helena, Montana. 1943.

This pamphlet contains a list of 64 species of fleas and their hosts in Montana, and a list of 51 mammal hosts and the fleas recorded from them.—D. J. B.

A NEW GENUS AND NEW SPECIES OF SYRPHIDAE (DIPTERA) FROM ECUADOR

C. L. FLUKE,
University of Wisconsin,
Madison, Wisconsin

Tuberculanostoma new genus

Small, shining black or blue black species with the face produced forward into a snout and with a very prominent tubercle. Head wider than the thorax. Eyes bare. Antennae medium to elongate, the arista dorsal and basal. Cilia on the upper occiput exceedingly long. Metasternum bare. Scutellum somewhat triangular, rugose, and usually with two slender bristles on the rim near the tip. Notopleura without a distinct tubercle. Otherwise like *Melanostoma*. Type of genus, *T. antennatum* n. sp.

In the genotype the front is broad and long, the antennae are elongate, the eyes of the male are dichoptic, and the genitalia are larger than normal for a small species. A second related species is similar but the genitalia are normal in size. Two other species are intermediate with holoptic eyes, shorter antennae, smaller front, but with a curved hair on the front femora of the male as is found in *Melanostoma ambiguum* Fallen. These latter two species indicate the close relationship of *Melanostoma* and may not be considered by some workers distinct enough to be included in *Tuberculanostoma*. The snout on all four is very similar but the tubercle does vary as indicated in the key and illustrations. These species all lack the notopleural tubercle that is so common on species of *Rhysops* and *Melanostoma*. They all form a very compact group and were collected at high altitudes in Ecuador by my friend F. Martin Brown. The holotypes are deposited in the American Museum of Natural History, New York City.

KEY TO SPECIES

1. Males 2
   Females 5
2. Eyes dichoptic, no peculiar curved hair at tip of front femora 3
   Eyes holoptic, front femora near tip with a black curled bristle 4
3. Genitalia large with long slender styles, facial tubercle nearer antennae than tip of snout ..... **antennatum**
   Genitalia normal, styles not exceptionally long, facial tubercle midway between oral tip and base of antennae ..... **cilium**
4. Hair of front femora and tibiae curly in addition to the single curled bristle ..... **browni**
   Stiff black bristles basal to curved bristle at tip of front femora (female unknown) ..... **pectinis**
5. Abdomen opaque with shining spots in the basal corners of the 3rd and 4th tergites, facial tubercle closer to oral tip than base of antennae, mesonotal pile mostly white ..... **browni**
   Abdomen shining, facial tubercle not closer to oral tip than base of antennae, mesonotal pile mostly black 6
6. Shining blue, antennae reaching almost to oral tip, front shining ... **antennatum**
   Color more greenish black, very little blue; antennae shorter, front with an opaque band ..... **cilium**

Tuberculanostoma antennatum new species

Figures 1, 2 and 3

Shining blue black, the antennae extending to the tips of the oral margin, eyes of the male dichoptic, genitalia large with long curved styles. Length 5 to 6 mm.

Male.—Head shining blue black with a rather large frontal triangle which is lightly white pollinose but with black bristly pile. Face well protruding forward, but not at all downward; a very prominent tubercle, which is closer to the antennal base than to the oral tips; sides of the face and cheeks very lightly white pollinose and with white pile. Eyes distinctly dichoptic. Ocellar triangle and upper occiput black with long black cilia. Antennae elongate, third segment equal to the first and second together, the first slightly longer than the second; third segment distinctly constricted on the basal third; arista basal, about the same length as the third segment, briefly pubescent.

Thorax everywhere shining blue black; pile of the mesonotum black, the scutellum black on the disc, but with white hairs along the edges; at the apex two widely separated rather long, slender black bristles; on each side of these terminal hairs there are often three or four more although they are usually shorter. Ventral fringe short, thin and white. Pile of the pleura sparse but practically all white. Legs everywhere black and the pile mostly whitish except on the middle tibiae where it is short and black. The hairs on the upper sides of the tarsi are usually black. On the under sides of the hind tarsi, the hairs form almost a thick yellowish mat.

Wings hyaline, blackish toward the base, the stigma yellowish. The costal margin with a fringe of short, black bristle-like hairs. Squamae white with yellowish fringe; plumule very much abbreviated, yellowish-brown in color; halteres yellow, the stalks brown.

Abdomen everywhere shining bluish-black. The pile practically all whitish, becoming black on the genitalia; the genitalia are quite large and the styles are extremely long and slender. In the preserved specimens, the abdomen has a constricted appearance at the apex of the third segment; at the point of extreme constriction, the abdomen is only half or one-third as wide as at the apex of the second segment.

Female.—Very similar to the male; the front rather wide, about three times as wide as the ocellar triangle and becoming considerably wider across the antennae; the pile all black. Antennae slightly shorter than on the male and the third segment not so conspicuously constricted. Abdomen more oval, but very highly polished blue-black.

Types.—Holotype male, Hda. Talahua, Province of Bolivar, 3100 meters, Ecuador, April 29, 1939 (F. M. Brown); allotype female, same place, April 28, 1939. Paratypes: one male, same data as holotype; three males and two females, same data as allotype.

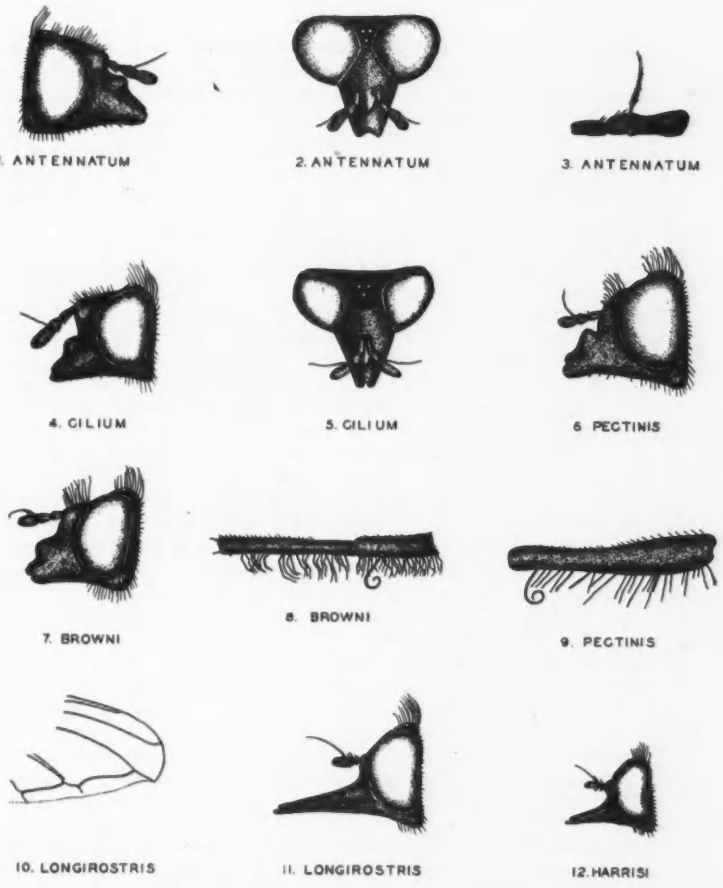


Figure 1. *Tuberculanostoma antennatum*, new species, profile of head of male. 2. *T. antennatum*, new species, top view of head of male. 3. *T. antennatum*, new species, antennae of male, inside view. 4. *T. cilium*, new species, profile of head of male. 5. *T. cilium*, new species, top view of head of female. 6. *T. pectinis*, new species, profile of head of male. 7. *T. browni*, new species, profile of head of male. 8. *T. browni*, new species, tibia and apical half of femur of male. 9. *T. pectinis*, new species, femur of male. 10. *Rhingia longirostris*, new species, apex of wing. 11. *R. longirostris*, new species, profile of head of male. 12. *R. harrisi*, Curran, profile of head of male.

All drawings were made with the aid of the camera lucida; head views were made to the same scale.

Tuberculanostoma cilium new species

Figures 4 and 5

Similar to ***antennatum*** but the tubercle is not so prominent and is placed midway between the antennal base and the oral angles. The antennae are also shorter. The abdomen is slender with parallel sides and the genitalia are normal. Length 7 mm.

Male.—Head shining black with bluish-green reflections. The frontal triangle large and lightly coated with brownish pollen, along the eyes with black pollen. Face considerably excavated above the tubercle and the upper slope of the tubercle forms a right angle with the line coming from the base of the antennae; slopes of the face and cheeks lightly dusted with white pollen which is somewhat darker just below the tubercle, the pile all whitish. Ocellar triangle equilateral with black pile and the cilia long and all black; the upper occiput shining and with short yellowish hairs. Eyes dichoptic, bare. Antennae dull black, reaching only to the upper oral edge, the first two segments together as long as the third, the third elongate and only slightly constricted near the base; arista black, pubescent, slightly longer than the third segment.

Thorax entirely shining blue-black with very fine dark pollen on the disc of the mesonotum and white pollen on the pleura; pile of the mesonotum sparse with the longer hairs black and the shorter hairs whitish, the white hairs more common across the front and along the sides. Scutellum shining with rather definite preapical depressions, in front of this, very faintly rugose; two long black apical bristles and a similar one on each side toward the base but more on the disc than on the rim; the rest of the pile is quite short, black and yellow mixed, the fringe whitish.

Legs entirely shining black with sparse white pile but with black pile on the outer sides of the femora and the upper sides of the four front tibiae and upper sides of all the tarsi. No peculiar hairs present anywhere.

Wings very slightly smoky, darker at the base, the stigma yellowish; squamae white with yellowish fringe; plumule slender and whitish at the tip, but brownish at the base; halteres yellow, their bases black.

Abdomen highly polished, only slightly opaque on the disc of the second segment and base of the third segment. Sides nearly parallel and narrower than the thorax, the pile whitish, becoming all black on the genitalia; a rather heavy tuft of black hairs on the bases of the styles. Genitalia much smaller than on ***antennatum***.

Female.—Front shining on the lower half, the upper half dark pollinose including the ocellar triangle; lower half very lightly coated with gray pollen. Mesonotum shining blue-greenish with a triangular dull area in front of the scutellum, this dull spot reaches almost to the middle of the mesonotum. The abdomen quite slender, but more oval than the male, no apparent dull markings on any of the tergites.

Types.—Holotype male, Minza Chica, Volcan Tungurahua, Ecuador, 3200 meters, April 8, 1939 (F. M. Brown). Allotype female, Hda.

Talahua, Province of Bolivar, 3100 meters, Ecuador, April 28, 1939 (F. M. & H. Brown).

Tuberculanostoma browni new species

Figures 7 and 8

Eyes of the male holoptic, tubercle of the face nearer the oral tips than base of the antennae; antennae short, the third segment oval; male front femora at the tips with a peculiar curved hair, other hairs on the front femora and tibiae shaggy; the abdomen mostly opaque, the genitalia small. Length about 6 mm.

Male.—Front normal, black with dark pollen and black pile; face highly polished, blue-black, the slopes next to the eyes with a small patch of dark pollen, the pile yellowish; cheeks shining black with white pile; ocellar triangle semi-shining black with black pile; the cilia long and black but with some shorter white hairs; the occiput gray pollinose and with whitish hairs. Eyes holoptic, bare. Antennae short, reaching only to the tips of the tubercle, the third segment heavily brownish pollinose; arista considerably thickened at the base, very faintly pubescent.

Mesonotum shining black, lightly brown pollinose which forms two very faint vittae at the middle; the pile rather long and mostly black, becoming white along the sides. Scutellum triangular, slightly rugose, pile long and black with six to eight bristle-like hairs on the margin, on the disc with shorter white hairs, the fringe short and white. Pleura rather highly polished, lightly dusted with while pollen; the pile brownish on the upper third of the mesopleura, other areas very sparse and white.

Legs black with mostly whitish pile; at the tips of the front femora a peculiar long, curved black bristle in addition to shaggy black and white hairs which become normal and are white at the base; on the outside of the front tibiae long, curly hairs which are black. Wings dilutely brownish, darker at the base, the stigma yellow; squamae yellowish-brown; plumule white; halteres yellow, the stalks black.

Abdomen opaque black, shining along the sides and on oval spots in the anterior corners of the third and fourth tergites; apex of the fourth segment, all of the fifth, and the genitalia highly polished. Venter shining, lightly dusted with white pollen, the pile rather long and white. Pile of the abdomen is white on the shining areas and mostly black and appressed on the opaque areas.

Female.—Front wide, very highly polished, but with a white pollinose triangle on each side on the lower half of the front next to the eyes; this triangle connects with the spot on the slopes of the face. Mesonotum semi-shining with brown pollen which forms three faint vittae especially on the posterior half. Pile of the mesonotum mostly short and yellowish with a few longer black hairs; pile of the scutellum almost entirely white; pile on the upper pleura all whitish. Abdomen similar to the male but more oval with the usual shiny side spots.

Types.—Holotype male, Urbina, Cerro Chimborazo, 3650 meters, Ecuador, April 18, 1939 (F. M. & H. Brown); allotype female, Hda.

Talahua, Province of Bolivar, 3100 meters, Ecuador, April 28, 1939 (F. M. Brown). Paratypes: four males, five females, same data as on the holotype; two males, five females, Cambre de Tililac, Cerro, Chimborazo, 4200 meters, Ecuador, April 21, 1939; two females (same data as allotype).

Tuberculanostoma pectinis new species

Figures 6 and 9

Tubercle nearer base of antennae than oral tip, front femora of male with a curled bristle and several strong black bristles basally, abdomen opaque with shining side spots. Length 6 mm.

Male.—Front broad, heavily coated with brown pollen which extends along the eyes to a larger triangular area just above the facial slit; pile of the front black. Face shining blue-black, dusted with white pollen, the tubercle rather large and highly polished; pile sparse, black above and white underneath and on the cheeks. Ocellar triangle shining with black pollen, the cilia long and black. Antennae black, first two segments subequal, the third shorter than the first two combined; arista black and thickened about the basal third and briefly pubescent. Eyes holoptic.

Thorax shining blue-black, mesonotum very lightly dulled with brownish pollen, pile rather long and black, but with shorter white hairs intermixed; scutellum with four or five transverse depressions, the pile long and black but with very short white pile intermixed, the fringe short and white. Pleura rather highly polished blue; the pile mostly pale, a few black hairs at the base of the plumule. Legs everywhere black; the pile black and white with a row of about seven or eight strong bristles on the outer sides of the front femora towards the tip; near the end of the front femora a strong black curled bristle. Wings hyaline, very slightly infuscated, the stigma yellow; squamae yellow; plumule dark brown; halteres yellow, the stalks black.

Abdomen with parallel sides, mostly opaque with highly polished triangles on the sides of each segment; apex of the fourth and following segments entirely shining. Pile mostly whitish or yellowish with blacker hairs toward the tip. Venter highly polished. Genitalia normal.

Types.—Holotype male, Hda. Talahua, Province of Bolivar, 3100 meters, Ecuador, April 28, 1939 (F. M. Brown).

Rhingia longirostris new species

Figures 10 and 11

Shining aeneous to blue. Fore margin of wings black. Snout long and slender, about 3 mm. in length. Body length 11 to 12 mm.

Male.—Head shining dark brown to black. Front black, lightly gray pollinose, especially along the eye margins; a narrow depression running from the shining arch to the vertex of the front. Snout long and cone shaped, mostly shining and very lightly pollinose on the face, lower slopes shining translucent. Cheeks yellowish

brown, lightly gray pollinose and with white pile. Ocellar triangle almost equilateral, opaque black and with long black pile. Upper occiput extremely thin with long, black cilia and a few shorter white hairs the entire length; lower occiput gray pollinose with white pile. Facets of the compound eye considerably enlarged on the upper third. Antennae reddish yellow, arista long and slender, very briefly pubescent.

Thorax shining black to reddish brown, the mesonotum with two broad, gray pollinose bands anteriorly, which end at transverse suture; the pile sparse but quite long and all black on the posterior half, shorter and with a few yellow hairs in front. The humeri and notopleura lightly gray pollinose, the latter with three or four long bristle like hairs; four or five bristly hairs on the postalar callosities. The pleura shining black, very lightly dusted and with brownish to black pile; a rather strong bristle or two on the upper edge of the mesopleura. Scutellum shining, brownish translucent with long, black hairs on the disc and a few shorter white ones next to the mesonotum, the rim with about ten long, black bristles; the ventral fringes white and long.

Legs shining, reddish brown to blackish; the pile practically all black, which is extremely long on the outer edges of the femora, basal hairs of the femora partly yellowish; at the apex of the second and third femora the long black hairs are curved outward.

Wings brownish, somewhat darker along the veins and almost black in the stigma and marginal cells; slightly cut in at the apex just beyond the tip of the third longitudinal vein. Squamae papery and mostly white in color with brown edge and long brown fringe; plumule yellowish; halteres yellow with brown knob.

Abdomen shining blue, the first segment and basal half of second segment more yellowish to brownish; pile short and appressed, yellow, longer and more erect along the sides.

Female.—Very similar, the front shining aeneous, very lightly brownish pollinose with black pile.

Types.—Holotype male, allotype female, Hde. Talahua, Province of Bolivar, Ecuador, 3100 meters, April 29, 1939 (F. M. Brown). Paratypes: one male and four females (same data). Received from Dr. C. H. Curran.

This species is separated from *harrisi* Curran (Figure 12) and other species known to me by its unusually long snout and dark wings.

THE BRAIN OF DROSOPHILA MELANOGASTER, by MAXWELL E. POWER. Jour. Morph. 72(3): 517–552, 6 figs. and 4 pls. 1943.

While it is not the Annals, general practice to notice papers that appear in other journals, this good piece of work (in a much neglected field) coming from the Yale Laboratories rates attention. When insect behavior is finally analyzed behaviorists should be able to correlate it with brain structure. This microstudy is one of the too infrequent efforts to describe the minute anatomy of the insect brain. The students of the genetics of Drosophila where so many mutations in the eye have been recognized are those who have an immediate interest in the accompanying brain structures.—C. H. K.

THE METAMORPHOSIS OF THE NERVOUS SYSTEM OF AEDES DORSALIS MEIGEN[1]

(Diptera: Culicidae)

TYLER A. WOOLLEY,
University of Utah,
Salt Lake City, Utah

This paper presents the results of an investigation of the histological and morphological changes occurring in the nervous system of *Aedes dorsalis* during metamorphosis. It is similar to that of Richins (1938) on the digestive tract of this species.

During metamorphosis various related and interdependent changes occur in the tissues and in gross structure. Many workers have demonstrated that each system of the body is subject to some type of alteration. Much of the research on the metamorphosis of insects has been limited to the changes which occur in the gross structure of organs, but a few writers have been concerned with the histological changes as well. These latter investigators have observed the breakdown of tissue and its reconstruction, the production of new tissue, the influences one organ has upon another, and the effects produced by the changes in each stage of development.

A review of the literature on metamorphosis seems to indicate that there are two groups of insects with respect to the changes of the nervous system: one group that is characterized by a marked degeneration and phagocytosis of the nerve tissue, and a second group that exhibits slight disintegration and histolysis of the nerve tissue *in situ* but is not characterized by phagocytosis.

"Histolysis of the larval nerve-cells, inferred by Weismann . . . for muscids, was first adequately proved by Bauer . . . for various insects." (Murray and Tiegs, 1935.) Tiegs (1922), discussing *Nasonia*, reported that complete destruction of the larval nervous tissue occurred. This was also reported by Sandchez for various insects. (Murray and Tiegs, 1935.)

Murray and Tiegs (*l. c.*) found that throughout the larval life of *Calandra* (Coleoptera) mitosis of cells may be seen, particularly in the later instars, and that active mitosis occurs in the cells comprising the optic lobes. Disintegration and phagocytosis of the larval nerve cells, however, occurs rarely, and degenerating nerve trunks are never found. The cells of the membrane investing the nervous system undergo similar changes.

---

[1]This paper is an abridgement of a thesis written at the University of Utah in partial fulfillment of the requirements for the degree of Master of Science.

In the preparation of this paper the author wishes to express his gratitude to Dr. R. V. Chamberlin, head of the Department of Zoology at the University of Utah, to Drs. Don. M. Rees, W. W. Newby, and Seville Flowers, who acted as a graduate committee, and to Dr. David T. Jones and other friends who were helpful and encouraging.

Schrader (1938), in discussing ***Ephestia kuhniella*** (Lepidoptera), states that the functional nerve cells of the larva do not divide during larval life, and that during the metamorphosis the larval brain cells degenerate ***in situ*** sporadically without phagocytosis. He also relates that all neuropile differentiations of the full grown larva are already present at the time of hatching. The brain increases much less in size than the body during the larval life, and its enlargement depends almost entirely upon an increase in number of cells.

Cody and Gray (1938), discussing the changes of the supraoesophageal and suboesophageal ganglia of ***Passalus cornutus*** (Coleoptera), state: "The principal change is in their size and this seems to be merely a matter of growth, as they retain their proportionate size in relation to the other ganglia." They further state that in the larval instars there is a noticeable, although very gradual, change in the nervous system. The number of ganglia remains constant, but those of the abdomen become more spherical and increase somewhat in size with the growth of the larva. The most marked change consists of a slow shortening of the connectives and consequent moving forward of the abdominal chain. In contrast to this slow and gradual change in the larva, Cody and Gray relate that there is a rapid increase in concentration of nerve tissue immediately after entrance into the pupal stage. This concentration continues until emergence.

Snodgrass (1924) states that the nervous system of ***Rhagoletis pomonella***, the apple maggot, undergoes more or less change in the pupa to arrive at the imago form. These developments are matters of direct transformation by growth of the nervous tissue.

Robertson (1936), found that in ***Drosophila*** no degenerative changes in the brain were observed and that the brain persists and grows throughout the period when other organs are degenerating.

Aedes dorsalis was found to be typical of the second group mentioned above; the nervous system does not undergo marked tissue degeneration, and the histolysis which does occur takes place ***in situ*** without phagocytosis.

MATERIALS AND METHODS

Material for this study was obtained from shallow pools of marshes and meadows west of Salt Lake City, Utah, and was transported to the laboratory in jars of water from the original habitat. Upon arrival at the laboratory the material was placed in culture jars over which were placed glass lamp chimneys to facilitate the capture of the adults for subsequent identification. Water from the original habitat was added to the culture jars from time to time to replenish the food supply of the larvae and to replace water lost through evaporation.

The larvae were identified individually under a binocular microscope. The larvae of *A. **dorsalis*** were placed in separate culture jars to develop while larvae of other species were discarded. Some of the larvae were reared to adults to check upon the identifications, and others were separated into sizes and allowed to develop. The latter were observed carefully, and, when moults occurred, some of the new instars were killed in fixative and others allowed to develop further. This provided a suitable series of specimens for study, and the various instars were found to be quite constant in developmental structures.

After the larvae had reached the fourth instar, the last larval stage, they were placed in separate jars for observation. They were examined every hour, and those which had pupated were taken out of the jars and the time recorded. The pupae thus obtained were then allowed to develop at a temperature of 23°–27° C. Pupae were killed at six-hour intervals up to fifty-two hours, the average time of emergence. They were killed in fixatives and preserved in 70% alcohol for further use.

Richins (1938) was followed closely in technique.

METAMORPHOSIS OF THE NERVOUS SYSTEM

Metamorphosis of the Brain (Plates I–III, IX).—The brain of the immature larva undergoes no great change, other than growth, in its development into the brain of a mature larva. The latter has a horizontal position and occupies approximately one-half of the cranial cavity. The brain is rather elongate and quite compact. Its crura cerebri are long and enter the small suboesophageal ganglia which lie in the neck region (figs. 3 and 4). The cells of the mature larval brain exhibit mitosis. The dividing cells are usually peripheral in position, but a few cells in the mid-portion of the gray matter show division.

During pupation the brain grows rapidly, and the lobes become larger and more bulbous. The brain becomes compacted into a fused mass which occupies approximately two-thirds of the cranial cavity. The compound eyes develop simultaneously with the growth of the brain, keeping pace with the enlarging optic lobes. In addition to the rapid growth of the cells there is a marked forward concentration of the nerve elements of the brain. The crura cerebri shorten, and the suboesophageal ganglia move into the head cavity from the neck region (see Plate II). These ganglia and the crura increase in size and become fused with the tritocerebrum (figs. 6 and 7). The crura cerebri remain no longer visible as distinct connectives. These structures so closely invest the oesophagus that in section it is difficult to distinguish the latter, except under high magnification (400–900×). During pupation of the larva numerous mitotic figures may be seen in the nerve cells of the brain. These figures, as in the larva, usually occurred in the peripheral cells, but a few cells of the mid-portions were seen dividing. Histolysis of the nerve tissue takes place *in situ* without phagocytosis. The new cells seem to be proliferated from the periphery of the brain, and the nerve cells of the midportions remain functional. Dividing cells were observed in newly emerged adults, but were not found in older specimens.

The brain of the imago (Plate III) is slightly larger than the pupal brain, and the lobes are well defined. The optic lobes reach their full development and appear fan-shaped. The three parts of the brain are fused with the suboesophageal ganglia and the crura cerebri into one neuropile. The compound eyes reach their full development and comprise almost the entire lateral head margin, approximating the expanded, fan-shaped optic lobes (fig. 8). The frontal ganglion remains quite constant in histological structure from the larva to adult, but shows slight modifications in shape (see Plate IX).

Metamorphosis of the Thoracic Ganglia (Plates IV–VI).—In both the immature and the mature larvae there are three pairs of thoracic

ganglia (fig. 15). Those of the mature larva differ only in size from those of the immature larva. Many of the peripheral nerve cells of the thoracic ganglia of the mature larva are in active division. The metathoracic ganglia of the mature larva are larger than the other two pairs, and during pupation they grow and become about twice as large. As a result they extend forward, meet the mesothoracic ganglia, and fuse with them. Thus these two pairs of ganglia appear as one large pair, the meso-metathoracic ganglia (figs. 20, 22).

The thoracic ganglia of the imago (Plate VI) appear as two pairs, the prothoracic and the meso-metathoracic ganglia. The latter innervates the wings and meso- and metathoracic legs. There is little evidence of mitosis in the nerve cells of the adult except in newly emerged specimens.

Histolysis is similar to that in the brain, and occurs ***in situ*** without phagocytosis; the new cells seem to be proliferated from the periphery of the ganglia.

Metamorphosis of the Abdominal Ganglia (Plate VII).—There are eight pairs of abdominal ganglia in both the immature and the mature larvae. Those of the mature larva are larger than those of the immature larva, although similar in structure. Mitosis was observed in the cells of both stages.

The chain of ganglia is shortened by the disappearance of the last pair of larval ganglia and its connectives, during the first hour of pupation. This last pair of ganglia has in the last larval stage a thick cell layer and, as in the other parts of the larval system, shows no sign of histolysis. Yet one hour after pupation this pair of ganglia completely disappears. An examination of the terminal nerves posterior to the seventh pair of ganglia shows the same structure as the terminal nerves behind the eighth pair of ganglia of the larva. Furthermore, the two pairs of lateral nerves of the eighth larval ganglia also disappear during this one-hour period. It was not possible to explain the cause of the disappearance of this eighth pair of ganglia. But, considering the lack of any sign of histolysis and considering the fact that the seventh pair of larval ganglia merges with the sixth by means of a shortening of their interconnection, it seems probable that the nerve elements of the eighth pair migrate forward and merge with those of the seventh. This hypothesis is further supported by the fact that the terminal ganglia of the one-hour pupa are somewhat larger than the seventh ganglia of the mature larva and by the fact that the terminal ganglia of the twelve-hour pupa has an exceedingly thick cortex of cells.

Seven pairs of abdominal ganglia occur in the six-hour pupa, but the twelve-hour pupa has only six pairs. The terminal pair of the twelve-hour pupa are formed by a fusion of the sixth and seventh pairs of the six-hour pupa and are quite long. There seems to be a concentration of cells in this last pair of ganglia, forming a thick layer around the scanty nerve fibers. These fused pairs of ganglia decrease in length from 320 microns in the twelve-hour pupa to 180 microns in the fifty-two-hour pupa. This occurs simultaneously with an elongation of the body up to the thirty-six-hour pupa, when the body begins to shorten slightly. There is a decrease in the lengths of both the ventral abdominal nerve cord and the body from the thirty-six-hour pupa to

the fifty-two-hour pupa. The terminal ganglia remain quite constant in length from the thirty-six-hour pupa (180 microns) to the emergence of the adult, when they become further shortened (150 microns).

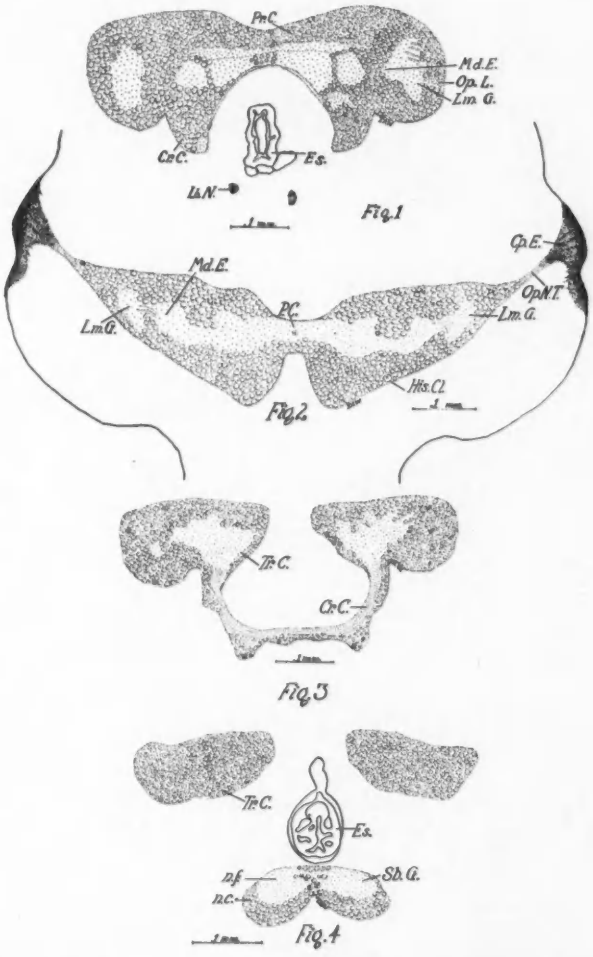
Mitosis was observed in the cells of all the pupal abdominal ganglia. The growth of these ganglia was almost imperceptible from the one-hour to the fifty-two-hour stage except that of the terminal ganglia, which enlarged due to fusion. There seemed to be a concentration of the nerve tissue and a shortening of the entire abdominal ganglionic chain from the six-hour pupa to the fifty-two-hour stage.

Histolysis took place *in situ* without phagocytosis, and the new cells seemed to be proliferated from the periphery of the ganglia.

The abdominal ganglia of the imago were similar to those found in the fifty-two-hour pupa and retained the same histological characteristics.

ABBREVIATIONS USED IN PLATES

Ab. Gng.	Abdominal Ganglion
6-7 Ab. Gng.	6th-7th Abdominal Ganglion
Ad.	Adipose tissue
An. C.	Antennal Center of Brain
An. N.	Antennal Nerve
b. w.	Body wall
Cr. C.	Crura Cerebri
Cp. E.	Compound Eye
Deu. C.	Deutocerebrum
Es.	Esophagus
Es. Con.	Esophageal Connective
Gng. Cl.	Ganglionic Cell
His. Cl.	Histolyzing Cell
Lb. N.	Labial Nerve
Lg. Cs.	Leg Case
Lg. N.	Leg Nerve
Lm. G.	Lamina Ganglionaris
Md. E.	Medulla Externa
Mes. Th. Gng.	Mesothoracic Ganglia
Met. Th. Gng.	Metathoracic Ganglia
Mes-Met. Th. Gng.	Meso-Metathoracic Ganglia
n. f.	Nerve fibers
n. c.	Nerve cells
Nv.	Nerve
Nv. Tr.	Nerve Tract
Or. J.	Organ of Johnston
Op. L.	Optic Lobe
Op. N.	Optic Nerve
Op. N. T.	Optic Nerve Trunk
P. C.	Pons Cerebralis
Pd.	Pedicle of Antenna
Pr. C.	Protocerebrum
Pro. Th. Gng.	Prothoracic Ganglia
Pr. Th.-Mes.-Met. Th. G.	Between Prothoracic and Meso-Metathoracic Ganglia
Rec. Nv.	Recurrent Nerve of Frontal Ganglion
Rd.	Sensillia of Antennal Organ
Ret. N.	Neuroglia Network
Sb. G.	Suboesophageal Ganglion
S. Cls.	Sensory cells
Sg. Nv.	Segmental Nerve
Ter. Nvs.	Terminal Nerves
Th. Con.	Thoracic Connective
v. b. w.	Ventral body wall
Wg. Nv.	Wing Nerve



Sections through the brain of a mature larva of *Aedes dorsalis*. Figure 1. Protocerebrum, vertical section. 2. Protocerebrum, horizontal section. 3.Triticerebrum, vertical section. 4. Tritocerebrum and suboesophageal ganglion.

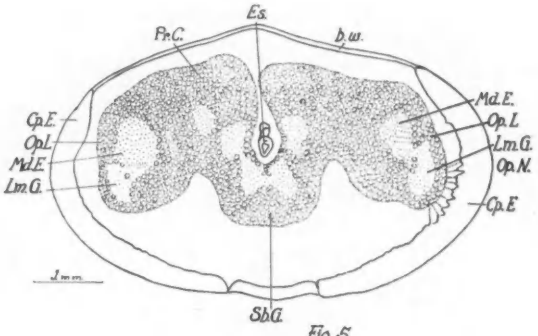


Fig. 5

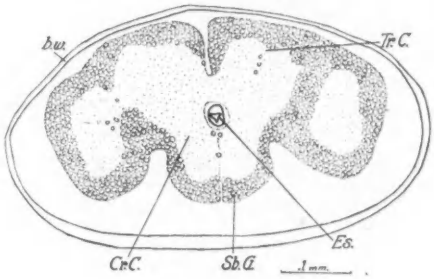


Fig. 6

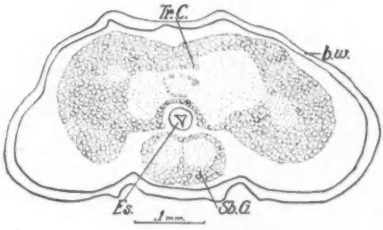


Fig. 7

Vertical sections through the brain of a 24-hour pupa of *Aedes dorsalis*. Figure 5. Protocerebrum. 6–7. Tritocerebrum.

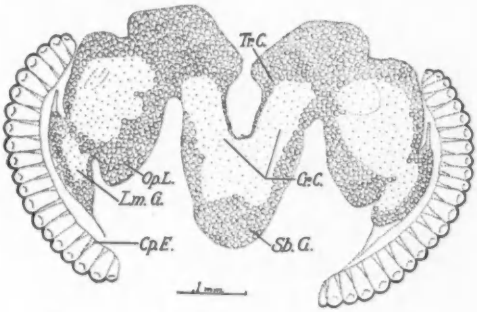


Fig. 8

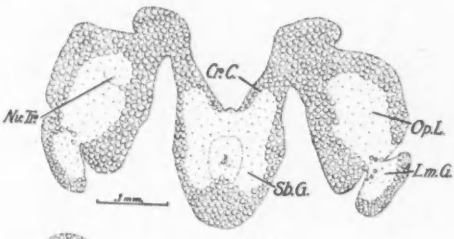


Fig. 9

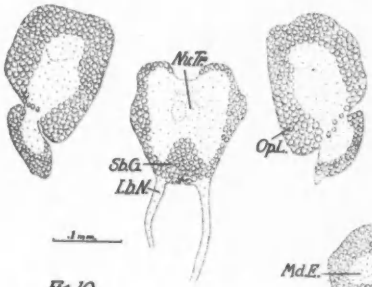


Fig. 10

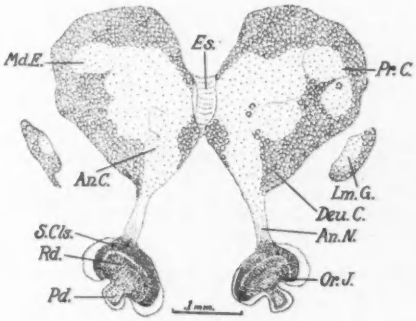
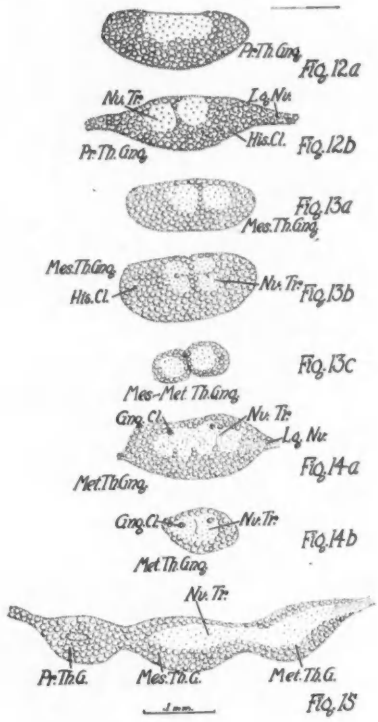
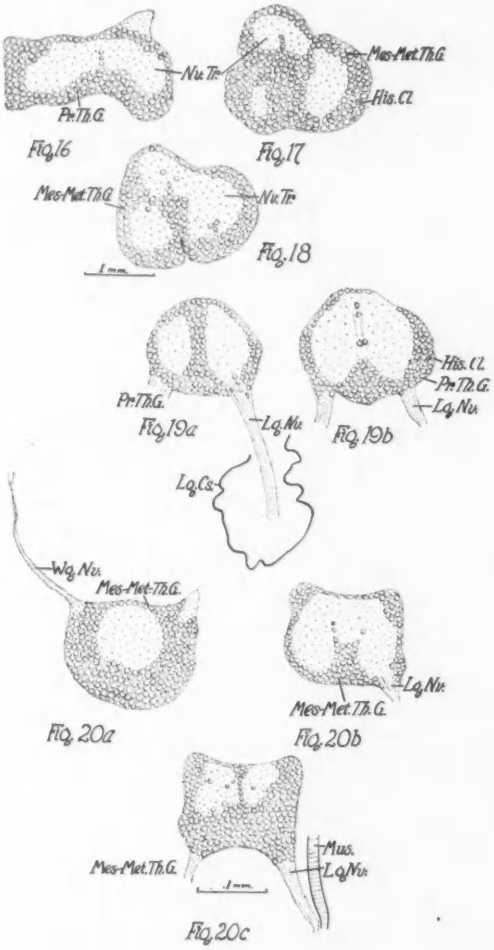


Fig. 11

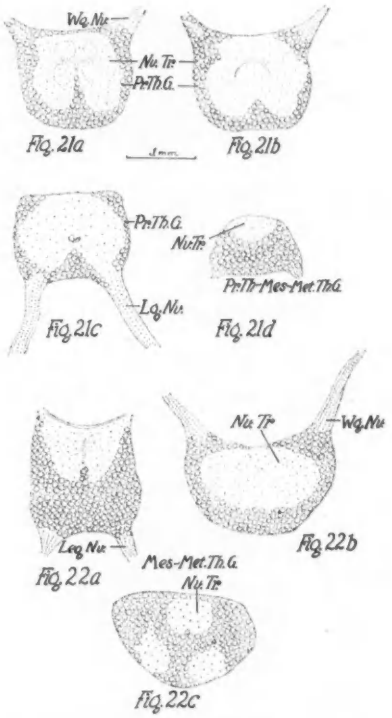
Vertical sections through the brain of the adult *Aedes dorsalis*. Figure 8. Protocerebrum. 9. Tritocerebrum. 10. Suboesophageal ganglion. 11. Deutocerebrum.



Vertical sections (except fig. 15, which is a longitudinal section) through the thoracic ganglia of the larva of *Aedes dorsalis*. Figure 12. Prothoracic ganglion (*b* posterior to *a*). 13. Mesothoracic ganglion (*b* and *c* posterior to *a*). 14. Metathoracic ganglion (*b* posterior to *a*). 15. Longitudinal section through the three thoracic ganglia.



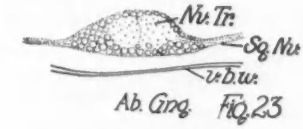
Vertical sections through the thoracic ganglia of the pupa of *Aedes dorsalis*. Figure 16. Prothoracic ganglion of early pupa. 17–18. Mesothoracic ganglion of early pupa (18 posterior to 17). 19. Prothoracic ganglion of late pupa (*b* posterior to *a*). 20. Meso-metathoracic ganglion of late pupa (*b* and *c* posterior to *a*).



Vertical sections through the thoracic ganglia of the adult of *Aedes dorsalis*. Figure 21. Prothoracic ganglion (*b-d* posterior to *a*). 22. Meso-metathoracic ganglion (*b* and *c* posterior to *a*).

EXPLANATION OF PLATE VII

Vertical sections through the abdominal ganglia of *Aedes dorsalis*. Figure 23. Typical abdominal ganglion of larva. 24. Terminal ganglion of larva (*b-f* posterior to *a*). 25. Terminal nerves of larva. 26. Typical abdominal ganglion of 24-hour pupa (*b* posterior to *a*). 27. Terminal abdominal ganglion of pupa (*b-d* posterior to *a*). 28. Terminal nerves of pupa (*b* posterior to *a*). 29. Typical abdominal ganglion of adult (*b-d* posterior to *a*). 30. Terminal ganglia of adult (*b-e* posterior to *a*). 31. Terminal nerves of adult.



Ab. Gng. FIG. 23

FIG. 24a

FIG. 24b

FIG. 24c

FIG. 24d

FIG. 25

FIG. 24e

FIG. 24f

FIG. 26a

FIG. 26b

FIG. 27a

FIG. 27b

FIG. 27c

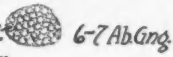


FIG. 27d

FIG. 28a

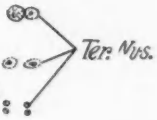


FIG. 28b

FIG. 29a

FIG. 29b

FIG. 29c

FIG. 29d

FIG. 30a

FIG. 30b

FIG. 30c

FIG. 30d

FIG. 30e

FIG. 31

Fig. 32a

Fig. 32b

Fig. 33a

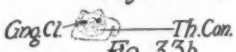


Fig. 33b

Fig. 34

Fig. 35

Fig. 36

Fig. 37a

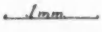

1 mm.

Fig. 37b

Fig. 38a

Fig. 38b

Fig. 39a

1 mm.

Fig. 39b

Fig. 40a

Fig. 40b

Fig. 40c

Fig. 41a

Fig. 41b

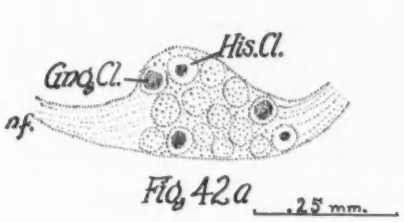


Fig. 42a

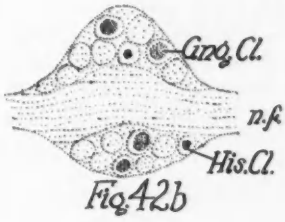


Fig. 42b

Fig. 43a

Fig. 43b

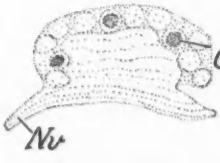


Fig. 44a

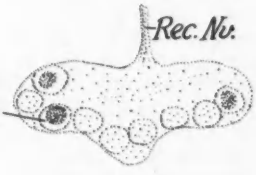


Fig. 44b

Vertical sections through the frontal ganglion of *Aedes dorsalis*. Figure 42. Frontal ganglion of larva (*b* posterior to *a*). 43. Frontal ganglion of pupa (*b* posterior to *a*). 44. Frontal ganglion of adult (*b* posterior to *a*.)

EXPLANATION OF PLATE VIII

Vertical sections through the connectives of *Aedes dorsalis*. Figure 32. Esophageal connectives of larva (*b* posterior to *a*). 33. Thoracic connectives of larva (*b* posterior to *a*). 34. Abdominal connectives of larva. 35. Beginning of an abdominal ganglion of larva. 36. Esophageal connectives of pupa. 37. Thoracic connectives of pupa (*b* posterior to *a*). 38. Abdominal connectives of pupa (*b* posterior to *a*). 39. Esophageal connectives of adult (*b* posterior to *a*). 40. Thoracic connectives of adult (*b* and *c* posterior to *a*). 41. Abdominal connectives of adult (*b* posterior to *a*).

DISCUSSION

The development of the larval brain into the pupal brain consists mainly of growth. The brain becomes approximately twice as large and occupies two-thirds of the cranial cavity of the pupa. It becomes more compact, the crura cerebri shorten, and the suboesophageal ganglia move forward from the neck region and become fused with the brain proper. The compound eyes develop simultaneously with the expanding optic lobes.

With few exceptions cell divisions occur mainly in the periphery of the cortex of the brain. The new cells seem to be proliferated from the peripheral portions of the brain, and histolysis takes place *in situ* without phagocytosis.

The frontal ganglion exhibits the same histological structure in each stage from the larva to adult, but changes slightly in shape.

The three pairs of thoracic ganglia of the larva are reduced to two pairs in the pupa by the fusion of the meso- and metathoracic pairs. This arrangement persists through the pupal stages into the adult. Growth occurs mainly in the fused, posterior pair.

There seems to be a forward concentration of the nerve tissues which accompanies the growth of the ganglia. With few exceptions cell division was found to occur mostly in the periphery of the ganglia. Histolysis occurred *in situ* without phagocytosis, and the new cells seemed to proliferate from the peripheral portions of the ganglia.

There are eight abdominal ganglia in the larval stage. Those of the mature larva are slightly larger than those of the immature larva. The terminal pair of ganglia, lateral nerves, and connectives disappear during pupation. There are seven pairs of ganglia in the one-hour and six-hour pupae, but there is a fusion of the sixth and seventh pairs in the twelve-hour pupa. This fusion results in six pairs of ganglia, and the larger terminal pair exhibits thick cell cortices.

The body elongates up to the thirty-six-hour pupa, when it shortens slightly. At the same time the pairs of abdominal ganglia shorten and seem to move forward as a result of a concentration of the nerve tissue. This continues from the six-hour pupa to the adult.

Cell divisions occur in the cells of the mature larva and throughout the pupal stages. The growth of the abdominal ganglia is imperceptible except for that of the fused pair of terminal ganglia. Histolysis occurs *in situ* without phagocytosis, and the new cells seem to be proliferated in the same manner as in the other ganglia.

CONCLUSIONS

1. Histolysis of the nervous tissue takes place *in situ* without phagocytosis. The new cells seem to proliferate from the periphery of the ganglia. Thus *Aedes dorsalis* is characteristic of those insects in which there is histolysis of the nervous tissue *in situ* without phagocytosis.

2. There is a shortening of connectives and a forward concentration of the nerve tissue which results in the fusion of the brain and suboesophageal ganglia, the meso- and metathoracic ganglia, and the sixth and seventh abdominal ganglia. This fusion occurs simultaneously

with an elongation of the body to the thirty-six-hour pupa and a subsequent shortening of the same to the fifty-two-hour pupa.

REFERENCES

Cody, Frances Perle, and **Gray, I. E.** 1938. The changes in the central nervous system during the life history of the beetle *Passalus cornutus* Fabricius. Jour. Morph., 62: 503–517.

Hanström, Bertil. 1928. Vergleichende Anatomie des Nervensystems der wirbellosen Tiere. pp. xi+628. Berlin: Julius Springer.

Murray, Florence V., and **Tiegs, O. W.** 1935. Metamorphosis of *Calandra*. Quart. Jour. Micr. Sci., 77: 405–495.

Richins, Calvin A. 1938. The metamorphosis of the digestive tract of *Aedes dorsalis* Meigen. Ann. Ent. Soc. Amer., 31: 74–87.

Robertson, Charles Wm. 1936. The metamorphosis of *Drosophila melanogaster*. Jour. Morph., 59: 351–401.

Schrader, Karl. 1938. Untersuchungen über die normalentwicklung des gehirns und gehirntransplantationen bei der mehlmotte *Ephestia kuhniella* zeller nebst einigen bemerkungen über das corpus allatum. Biol. Zentralbl., 58(½): 52–90 (Biological Abstracts, 1938, No. 15475).

Snodgrass, R. E. 1924. Anatomy and metamorphosis of the apple maggot. Jour. Agric. Res., 28: 1–36.

Tiegs, O. W. 1922. Researches on the insect metamorphosis. Roy. Soc. South Australia, 46.

THE C. V. RILEY CENTENNIAL EXHIBITION, MUSEUM OF NATIONAL EXPANSION, ST. LOUIS

Entomologists will be interested in hearing of our plans for celebrating the centennial of the birth of C. V. Riley. The Jefferson National Expansion Memorial is a national historic site established to commemorate the westward movement of the American people. Because Riley made outstanding contributions to the successful advance of agriculture into the West, and also because he did some of his work actually within the area of the Memorial, the National Park Service is arranging a special Riley centennial exhibition to be held in the Museum of National Expansion in St. Louis.

The exhibition will outline Riley's career, point out his accomplishments as an artist and his productivity as a scientific writer, and will illustrate his work on two insects important in western agriculture—the Rocky Mountain locust and the cottony cushion scale. It will be opened on the evening of September 22 with a public meeting sponsored jointly by the St. Louis Academy of Science and the Jefferson National Expansion Memorial, the program featuring an illustrated lecture on Riley and his work by Dr. E. P. Meiners of St. Louis. The exhibition will remain on view through October 24. Material for display is being generously loaned by the American Museum of Natural History (Dr. Frank E. Lutz), the University of California (Dr. E. O. Essig), and the Montana State College (Dr. Harlow B. Mills).

JULIAN C. SPOTTS, *Superintendent,*
Jefferson National Expansion Memorial.

A NEW GENUS—STONEANA—AND THREE NEW SPECIES OF MEXICAN LEAFHOPPERS

(Homoptera: Cicadellidae)

DWIGHT M. DeLONG,
Ohio State University,
Columbus, Ohio

In 1936, Dr. E. D. Ball in company with Mr. W. E. Stone who is with the U. S. Bureau of Entomology and Plant Quarantine stationed in Mexico City, collected several species of Mexican leafhoppers. A very interesting species collected at that time was apparently not described and does not belong to a known genus. Dr. Ball had, therefore, planned before becoming seriously ill to name the genus for Mr. Stone and the species for Mrs. Stone and their daughter, both of whom have the given name Martha. Since Dr. Ball has not recovered and will probably not again be able to carry on his taxonomic studies, and since I have been working over a large amount of Mexican material, I am happy to name both the genus and species as he had planned and also in honor of my good friends, the three members of the Stone family.

Genus **Stoneana** nov.

Closely related to *Aligia*. The vertex is conspicuously depressed just behind the margin, causing the apex, in lateral view, to appear as a dorsally produced ridge. The margin is not sharp, the face extending to the top of the marginal ridge. The vertex is short and broad as in *Aligia*. The elytra contains the two cross veins and many supernumerary cross veins especially on the clavus, costa and first anteapical cell.

Genotype *Stoneana marthae*, n. sp.

Stoneana marthae, new species

A white to pale yellow species with orange and black markings. Length 4.5 to 5 mm.

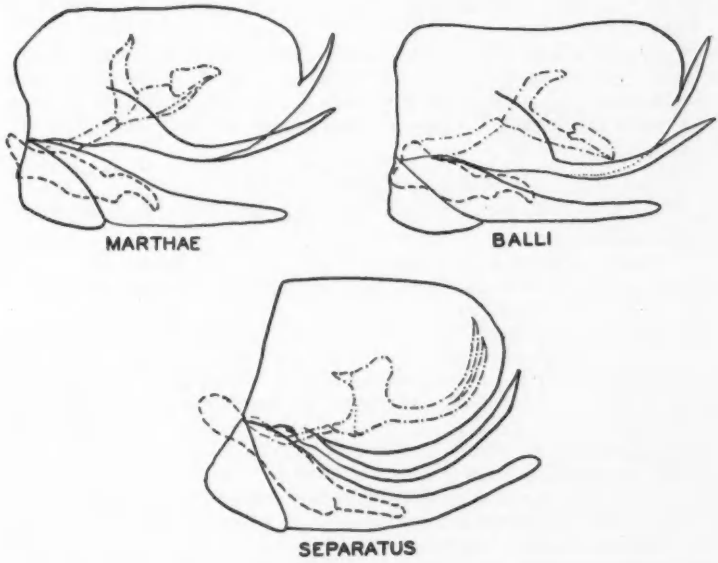
Vertex short, rather broadly roundedly produced, and appearing almost parallel-margined, twice as broad as median length.

Color.—White to yellow, vertex with a pair of proximal angular black spots at apex, and a smaller one next to the eye on either side just below ocellus. Disc usually orange. Pronotum mostly orange with a median longitudinal white stripe, an oblique spot on either side, and a white spot behind each eye near lateral margin. Pronotum pale with darker basal angles and a black angular spot on either side of apex. Elytra white with orange veins, crossveins and orange blotches, giving the elytra the appearance of being spotted with white. Face white.

Genitalia.—Last ventral segment of female with produced lateral angles, between which the posterior margin is broadly and rather deeply concavely excavated on either side of a broad medially pro-

duced tooth which is slightly notched at apex. Male valve broad and rounded, plates long, triangular. Aedeagus L-shaped with a basal erect portion and the thickest and largest portion extending caudally. The apical half is sloped upwards on the ventral side to form a narrow blunt apex, just anterior to which is a short angled wing-like projection on either side. The ventral portion of the pygofer gives rise to a long black spine at about half its length which extends to the tip of pygofer. Also, a short black pointed spine arises on the ventral caudal margin of the pygofer and extends a little farther than the basal spines.

Holotype male, allotype female and male and female paratypes collected on the Cuernavaca-Acapulco Road, August 29, 1936, by Ball and Stone. Holotype male, allotype female and male and female paratypes in Ball's collection. Paratype male and female in author's collection.



Stoneana balli, new species

In form and general appearance resembling *marthae*, but with darker coloration and slightly different male genitalia. Length 4.5 mm.

Vertex broadly rounded, less than twice as wide between eyes at base as median length.

Color.—Vertex pale yellow, with a broad, angular orange spot on either side on basal two-thirds. Each spot extends from eye to middle in front and tapers to about the middle on either side at base having a white spot at middle and an angular white spot next

the base of either eye. Margin with a large angular black spot on either side of apex. A small round black spot just above each ocellus and a pair of black spots next to each eye. The ventral spot below the margin is the larger. Face yellow with pale brown arcs on either side of middle. Pronotum dark brown with five pale spots across middle. Scutellum brownish with apical third paler, a black angular spot on either side of apex. Elytra whitish subhyaline, veins dark brown and with paler brown mottling on clavus and disc.

Genitalia.—Male valve rather short, broad, and rounded at apex. Plates elongate, triangular. Aedeagus L-shaped as in ***marthae*** with a basal erect portion and a thicker caudal portion which bears a rather conspicuous wing-like process on either side of the apical half just before the blunt, rounded apex. As in the case of ***marthae***, a long black spine arises at about the middle of the pygofer on ventral margin and extends to its apex. Also a short black spine arises on the apical ventral portion of the pygofer and is directed almost dorsally. The apical spine in this species is heavier than the same spine in ***marthae***.

Holotype male and paratype male collected on the Cuernavaca-Acapulco Road, August 23 and 24, by Ball and Stone. Paratype males collected at Jacala, Hgo., Mexico, August 13, 1936, by Dr. E. D. Ball. Holotype and paratypes in Ball collection. Paratype male in author's collection.

Stoneana separatus, new species

Resembling ***balli*** in form and color but with distinct male genitalia. Length 5 mm.

Vertex more produced than in ***balli***, but rounded at apex, more than half as long at middle as basal width between the eyes.

Color.—Vertex white with a broad orange spot on either side between anterior margins of the eyes which tapers to a narrow spot at base. Margin with a large black spot on either side of apex, a smaller spot just above each ocellus, and a black spot next to eye just below each ocellus. Face pale with light brown arcs and coloration on either side of middle. Pronotum orange brown with four large white spots across middle and a longitudinal pale stripe. Scutellum pale with brownish basal angles and tinted with orange on middle and a black angular spot on either side of apex. Elytra white with dark brown veins and brownish mottling especially on clavus.

Genitalia.—Male valve very short, almost transverse. Plates elongate, triangular, rather broad at base, tapered to narrow blunt apices. Aedeagus with a rather broad basal portion which appears square and extends dorsally. At the base of this portion a narrow process extends caudally then curves dorsally, the apical half of which, extending from about the beginning of the curved portion, is cleft, forming two slightly separated pieces. The pygofer bears only one spine which arises near the base on the ventral margin and extends almost to the apex of pygofer.

Holotype male and paratype male collected at Yetia, Gro., Mexico, August 11, 1930 (M. F. 1756) by J. Parra. Holotype and paratype in author's collection.

A NEW PHILIPPINE NIPPONONYSSON WITH REMARKS ON THE AFFINITIES OF THE GENUS

(Hymenoptera: Nyssonidae)

KARL V. KROMBEIN,
Bureau of Entomology and Plant Quarantine,
United States Department of Agriculture

The description of the following new *Nippononysson* is published at this time so that a name will be available for use in the notes which follow on the affinities of the genus.

Nippononysson adiaphilus,[1] new species

Type.—Female, Samar Island, Philippines (C. F. Baker) (United States National Museum, Type No. 56316).

Female.—Length 8 mm. Black, with the following ferruginous: Mandible medially, tegula, fore tibia on outer side, middle tibia on outer side at base, hind femur and tibia except at apex, all tarsi, and first three abdominal segments. Pubescence moderately abundant, short, appressed, and silvery. Wings subhyaline, densely hairy; stigma dark brown, nervures lighter, tending toward ferruginous; venation similar to that of *rufopictus*, except that the cubital vein of the forewing is present beyond the second submarginal cell only as a short stub whereas this vein extends to the wing margin in *rufopictus*.

Head shining; clypeus transversely tumid distally, apical third impunctate and with a narrow, transverse flange apically, the margin of which is not noticeably emarginate laterally as it is in *rufopictus*; front with a very short, low, median, longitudinal keel just above and between antennal scrobes, and with fine, moderately close punctures; ocelli closely placed in a triangle, postocellar distance about half ocellocular distance; vertex less closely but as finely punctured as the front.

Thorax subopaque; pronotal disk with scattered fine punctures anteriorly, posteriorly with a transverse row of fairly large, shallow pits; lateral surface of pronotum with oblique carinae above, and with longitudinal carinae below; mesoscutum with moderately numerous, fine punctures among which are scattered some larger, sparser punctures; mesoscutal laminae raised slightly above level of rest of mesoscutum, truncate and declivous posteriorly and extending slightly beyond remainder of mesoscutum; scutellum tumid, posteriorly with a broad, deep, longitudinal groove so that it appears bilobate, anteriorly with close, fine punctures, posteriorly with subcontiguous pits; postscutellum less tumid than scutellum, and with irregular rugae; mesopleuron anterior to epicnemial furrow smooth, except for piliferous micropunctures, posteriorly with large, irregular reticulations;

[1]Derivation: *adia*, Greek, *adeia*, freedom, etc.; *philus*, Greek, *phileo*, to love. In allusion to the country of its origin, rather than to its possible habits.

metapleuron smooth except for piliferous micropunctures; dorsum of propodeum irregularly reticulate, with enclosed area indistinctly set off, sides convergent toward rear and broadly rounded posteriorly, median length about three-fourths basal width; posterior surface of propodeum with irregular reticulations which are same size as those on anterior half of dorsal surface; lateral surface of propodeum smooth on anterior half, and with longitudinal to oblique carinae posteriorly.

Abdomen shining; first tergum with small, scattered punctures, except for the postero-lateral concentration of close punctures; second tergum with median punctures sparse, the density becoming gradually more concentrated laterad until, from lateral fifth to extreme side the punctures are separated by a puncture's width or less; third and fourth terga largely telescoped beneath second, but apparently the arrangement of punctures is similar to that of the second; fifth tergite with punctures regularly spaced with a distance of two or three puncture widths between most of them; sixth tergum laterally and basally with punctures slightly more concentrated than on fifth, pygidial ridges sharp and reflexed on apical half of segment, posterior half of pygidium impunctate, apical margin narrowly rounded; first sternum with paired median carinae sharp, well defined, much less divergent posteriorly than in ***rufopictus***, not enclosing a short, median carina on apical sixth as in ***rufopictus***, free margin of carinae sinuate as viewed from side, remainder of sternum delicately, finely, and irregularly reticulate; second sternum extremely tumid medially, in profile anterior and posterior slopes meeting at almost a right angle, punctures medially and anteriorly sparse, gradually increasing in concentration posteriorly and laterally until they are separated by a puncture's width or less; third and fourth sterna not visible; fifth sternum with moderately close punctures on posterior half; sixth sternum impunctate medially, laterally with moderately close punctures.

Male.—Unknown.

Remarks.—The genus was known previously only from the genotypic species, ***Nippononysson rufopictus*** Yasumatsu and Maidl[2], from Kyûshû, Japan, and Amami-Oshima, Rykûyû Islands.

The following couplet will serve to separate ***adiaphilus*** from ***rufopictus*** until material of the latter species is at hand. The key characters in parentheses have been taken from the illustrations accompanying the original description of ***rufopictus***; the other characters of ***rufopictus*** are from the original description.

Paired median carinae of first abdominal sternum very slightly divergent posteriorly and not enclosing a short, median carina on apical sixth; first three abdominal segments ferruginous; fore tibia on outer side, middle tibia on outer side at base, hind femur and tibia except at apex, and all tarsi ferruginous; postocellar distance about half the ocellocular distance; apical margin of clypeus not noticeably emarginate laterally; cubital vein in forewing extending only a short distance beyond second submarginal cell, **adiaphilus**

---

[2]Yasumatsu and Maidl. Festchr. 60 Geburtst. E. Strand, i, pp. 501–4, pl. 13; 1936.

Paired median carinae of first abdominal sternum noticeably divergent posteriorly and enclosing a short, median carina on apical sixth; first two abdominal segments ferruginous; legs black; (postocellar distance subequal to ocellocular distance; apical margin of clypeus noticeably emarginate laterally; cubital vein in forewing extending to wing margin)..... **rufopictus**

GENERIC AFFINITIES OF NIPPONONYSSON

The genus *Nippononysson* was assigned originally[2] to the Nyssoninae with the notation that it was close to *Nysson* and *Hyponysson*. The characters of the hind femur and tibia and front were omitted so that it was impossible for Pate[3] to assign it to a definite position in his proposed classification of the Nyssonini. However, Pate assumed that the hind femur and tibia were simple and unarmed and that the frontal keel was lacking owing to the fact that the figures and failure to note any distinquishing features of these members in the original description implied the lack of modification of these structures. An examination of the Philippine *adiaphilus* shows that Pate was correct in his assumption though there is a short median keel on the front above the antennae.

Pate's graphical representation of the evolutionary trends of the Nyssonini (p. 124) shows that *Foxia* lacks a median keel on the front, but his generic diagnosis (p. 144) indicates that the front may have a short keel or tubercle. Several females of *Foxia pacifica* Ashmead in the United States National Museum collection have such a short frontal keel and it is similar in length and development to that of *adiaphilus*.

Pate's tribal diagnosis (p. 121) indicates that the dorsal caudolateral angles of the propodeum are unarmed in *Nippononysson* (in contrast to all other Nyssonini) and that the forewing of this genus has only two submarginal cells and a larger stigma than normally. The Philippine specimen agrees with *rufopictus* in these respects. Pate states also that the epicnemial furrow (omaulus) is generally obsolete in the Nyssonini, but this is very well developed in *Nippononysson*. The genus agrees with the other tribal characters.

However, superficially the genus bears a much stronger resemblance to certain of the genera of the Gorytini than it does to any of the Nyssonini and it may be of interest to examine it in the light of this resemblance. The chief characters which would place it with the Gorytini are the unarmed propodeum, large stigma, and type of integument. The size of the stigma is subject to some variation among the various groups of Nyssonini (see Pate's figures 2 and 3 of *Metanysson* (*Metanysson*) and *Metanysson* (*Huachuca*)), and is hardly a valid reason for excluding *Nippononysson* from the Nyssonini.

In my opinion the lack of teeth or spines at the dorsal caudolateral angles of the propodeum may be associated with the comparative thickness and sculpture of the integument. All Nyssonini, except *Nippononysson*, have a very thick, coarsely sculptured integument which presumably gives the nyssonine considerable protection from the aculeates upon which it is parasitic. In *Nippononysson*, however, the integument of the head and abdomen is very much thinner, and minutely and shallowly punctate, and that of the thorax is not much thicker or

[3]Pate, V. S. L. Trans. Amer. Ent. Soc., lxiv, pp. 117–190, pls. 7–8, 1938.

more coarsely sculptured than that of the nonparasitic Gorytini, e. g., *Hoplisoides* Gribodo and *Gorytes* Latreille. This may possibly indicate that *Nippononysson* is not a parasite, or has not become so perfectly adapted to parasitic life as the other nyssonines. However, it does not seem practical to make parasitic or nonparasitic habits a criterion for determining whether a genus belongs to one tribe or another.

The fact that the meso- and metasternal characters of *Nippononysson* are similar to those of the Nyssonini and dissimilar to those of the Gorytini is a much more valid reason for including it in the former tribe rather than the latter, and, I think, a much better indication of its true affinities than any of the characters mentioned in the two paragraphs immediately above.

The simple hind femur and tibia and poorly developed frontal keel (as in *Foxia* Ashmead and *Hyponysson* Cresson) indicate the generalized condition of *Nippononysson*. The thinner, more finely sculptured integument, lack of propodeal spines or teeth, and very large stigma seem to indicate that *Nippononysson* belongs much closer to the primitive nyssonine stock than any of the existing genera. This theory would be strengthened by the possible future discovery that the species are not parasitic as are certain of the other Nyssonini.

STUDIES IN THE GENETICS OF DROSOPHILA. III. THE DROSOPHILIDAE OF THE SOUTHWEST. Directed by J. T. PATTERSON. Pages 1–327, 66 figures plus 25 plates (10 in color), 7 x 10 inches, paper bound. The University of Texas Publication, No. 4313. Published by THE UNIVERSITY OF TEXAS, Austin, Texas. 1943. Price, $2.50.

The first two publications in this series dealt primarily with chromosomal aberrations (Part I, 1940), and gene variation and evolution (Part II, 1942); the present publication is a general account of the various species of Drosophila which occur in southwestern United States and northern Mexico. This account is divided into three sections: I—The Drosophilidae of the Southwest, by J. T. Patterson; II—Geographical Distribution of Species of the Genus Drosophila in the United States and Mexico, by J. T. Patterson and R. P. Wagner; III—Analysis of the Metaphase and Salivary Chromosome Morphology Within the Genus Drosophila, by Linda T. Wharton.

Part I (pp. 7–216) is concerned primarily with the systematics of the family Drosophilidae, but contains a short section on methods of collecting Drosophila, and a report of field studies on fluctuations in Drosophila populations. The systematic section contains detailed descriptions of the more than a hundred species of Drosophilidae (mostly in the genus Drosophila), of which 24 are described as new; a key to 111 North American species of Drosophila (not including a number of species described by Duda in 1925, nor the new forms described in this publication), 11 tables summarizing the collection records of 905,047 specimens, and some excellent illustrations. There are 65 figures of line drawings, illustrating chiefly the internal reproductive systems of both sexes, the egg, and the puparium of most of the species, and ten colored plates illustrating 73 forms (drawn from living specimens).

Part II (pp. 217–281) is a comprehensive treatment of the geographical distribution of these flies, and contains 16 distribution maps and 30 tables. Part III (pp. 282–319) represents a continuation of Dr. Wharton's study on the chromosomes of the *repleta* group, which was published last year in Publication II of this series; it contains 15 plates of chromosome figures.

In looking over this publication, we are particularly impressed by the thoroughness with which the study was made, and the values to science generally to be derived from cooperative effort in studies of this sort. Entomologists may well emulate the Texas group responsible for this ser es of publications.—D. J. B.

MEMBRACIDAE OF GUATEMALA

W. D. FUNKHOUSER,
University of Kentucky,
Lexington, Ky.

As a result of a rather intensive and very successful collecting trip in Guatemala in 1942, it has been possible not only to recognize practically all of the species of Membracidae which have been reported from that country, but to add a large number of new locality records and to describe sixteen new species.

Since no check-list or catalogue of the Guatemalan Membracidae has ever been published, we are here recording for each species the reference to the original description, any changes in synonymy and the locality records. This list includes all of the species of Membracidae which have been reported from Guatemala in the literature of the family.

Subfamily **Membracinae**

Bolbonota cuneata Fowler

1894. *Bolbonota cuneata* Fowler, B. C. A.,[1] p. 17; Tab. 2, figs. 4, 4a, 4b.

San Isidro (Champion, 1894).

Bolbonota inconspicua Fowler

1894. *Bolbonota inconspicua* Fowler, B. C. A., p. 18; Tab. 2, figs. 5, 5a.

El Tumbador (Champion, 1894); Chimaltenango (W. D. F., 1942).

Bolbonota insignis Fowler

1894. *Bolbonota insignis* Fowler, B. C. A., p. 17; Tab. 2, figs. 2, 2a, 3.

Vera Paz (Champion, 1894).

Bolbonota pictipennis Fairmaire

1846. *Bolbonota pictipennis* Fairmaire, Revue Membracides, p. 258.
1851. *Tetraplatys atomarius* Walker, List Homoptera British Museum, p. 510.

Rio Naranjo, Las Mercedes, Cerro Zunil, Vera Paz (Champion, 1894); Zarazoga (W. D. F., 1942).

Bolbonota atitla sp. nov.

(Figure 1)

Large, globose, corrugated, shining brown, coarsely punctate, not pubescent; pronotum swollen, arcuate, dorsal margin irregular, two deep depressions on each side, suddenly depressed before posterior process; posterior process almost reaching tips of tegmina; tegmina black with yellow spots; head and legs strongly foliaceous; under surface extending far below tegmina. This species is nearest to *B.*

[1]Biologia Centrali-Americana. Insecta. Rhynchota. Hemiptera-Homoptera, Vol. II, Part I.

corrugata Fowler, but is larger and has the pronotal convolutions in a different arrangement.

Head foliaceous, quadrangular, wider than long, finely punctate, sparingly pubescent, roughly sculptured; base regularly arcuate; eyes gray; ocelli conspicuous, white, glassy, farther from each other than from the eyes and situated slightly above a line drawn through centers of eyes; inferior margins of genae short and rounded; clypeus very large, foliaceous, extending for two-thirds its length below inferior margins of genae and projecting laterad beyond the genae in sharp angles, tip pointed.

Pronotum bright reddish-brown, coarsely punctate, not pubescent; roughly sculptured and corrugated with ridges and depressions; three rounded ridges on each side separated by deep fossae; dorsal margin arcuate and irregular, suddenly depressed before posterior process; metopidium sloping above the head, wider than high, with two longitudinal ridges on each side; median carina strongly percurrent; humeral angles heavy, blunt, triangular; posterior process short, heavy, depressed at tip, not quite reaching tips of tegmina.

Tegmina entirely exposed, broad, black with irregular yellow spots, opaque; base widely coriaceous and punctate; five apical and four discoidal cells; apical limbus broad and wrinkled.

Under surface of body swollen, brown; first two pairs of tibiae very foliaceous; hind tibiae swollen at distal end; femora and tibiae brown; tarsi yellow.

Length from front of head to tips of tegmina 4 mm.; width between humeral angles 3.2 mm.

Described from a single female taken at Lake Atitlan, Guatemala, on February 18, 1942. Type in author's collection.

Enchenopa quadricolor Walker

1858. *Enchenopa quadricolor* Walker, Insecta Saundersiana, p. 60.
1858. *Enchenopa subangulata* Walker, Ins. Saund., p. 61.
1858. *Enchenopa excelsior* Walker, Ins. Saund., p. 61.
1858. *Enchenopa humilior* Walker, Ins. Saund., p. 62.
1858. *Enchenopa curvicornis* Walker, Ins. Saund., p. 62.

Guatemala City (Champion, 1894); (W. D. F., 1942).

Enchenopa bifusifera Walker

1858. *Enchenopa bifusifera* Walker, List Hom. B. M. Suppl., p. 125.

Chichicastenango (W. D. F., 1942).

Enchenopa ansera sp. nov.

(Figure 2)

Jet black with two white spots on dorsal margin; finely punctate, not pubescent; pronotal horn at first porrect and then strongly curved forward; lateral carinae reaching margins of pronotum; posterior process reaching just beyond internal angle of tegmen; tegmina black; head and legs foliaceous; under surface and legs black, tarsi white.

Head foliaceous, quadrate, black, finely punctate, not pubescent; base straight; eyes black with white border; ocelli conspicuous, pearly,

shining, twice as far from each other as from the eyes and situated about on a line drawn through centers of eyes; inferior margins of genae slightly sinuate; clypeus very large, foliaceous, extending for two-thirds its length below inferior margins of genae, tip broadly truncate.

Pronotum black, finely punctate, not pubescent; two white spots on dorsal margin; pronotal horn long, heavy, blunt, strongly curved forward, strong sharp dorsal and lateral carinae, the lateral carinae equidistant from the dorsal and ventral margins of the horn and extending to margins of pronotum, both dorsal and ventral margins of horn foliaceous; metopidium sloping forward from head, higher than wide; humeral angles short, triangular and blunt; posterior process slender, very acuminate, extending just beyond internal angles of tegmina.

Tegmina entirely exposed; black and opaque; five apical and three discoidal cells; apical limbus broad and wrinkled.

Under surface of body black; femora and tibiae black; tarsi white; front and middle tibiae very foliaceous.

Length from front of head to tips of tegmina 4.5 mm.; length from eyes to tip of pronotal horn 3 mm.; width between humeral angles 1.8 mm.

Described from a single male collected on the shore of Lake Atitlan, Guatemala, on February 25, 1942. Type in author's collection.

Enchophyllum albidum Fowler

1894. *Enchophyllum albidum* Fowler, B. C. A., p. 7; Tab. 1, figs. 8, 8a.

San Geronimo (Champion, 1894).

Enchophyllum dubium Fowler

1894. *Enchophyllum dubium* Fowler, B. C. A., p. 8, Tab. 1, figs. 9, 9a, 9b.

Teleman, Vera Paz (Champion, 1894).

Enchophyllum melaleucum Walker

1858. *Enchenopa melaleuca* Walker, Ins. Saund., p. 59.
1894. *Enchophyllum melaleucum* Fowler, B. C. A., p. 7; Tab. 1, figs. 7, 7a, 7b.

Sabo, Cerro Zunil (Champion, 1894).

Erechtia sallaei Fowler

1894. *Tropidoscyta sallaei* Fowler, B. C. A., p. 13; Tab. 1, figs. 19, 19a.
1903. *Bolbonota sallaei* Buckton, Monograph of Membracidae, p. 52.
1928. *Erechtia sallaei* Goding, Jour. N. Y. Ent. Soc., 36: 219.

San Geronimo (Champion, 1894).

Hypsoprora coronata Fabricius

1803. *Membracis coronata* Fabricius, Syst. Rhyng., p. 14.
1851. *Pterygia varia* Walker, List Hom. B. M., p. 502.
1859. *Pterygia coronata* Dohrn, Catalogue of Hemiptera, p. 77.
1869. *Aechmorpha coronata* Stål, Bid. Memb. Kan., p. 279.
1894. *Hypsoprora coronata* Fowler, B. C. A., p. 26; Tab. 2, figs. 17, 17a, 17b.

Chicam, Vera Paz (Champion, 1894).

Hypsoprora nigerrima Fowler

1894. *Hypsoprora nigerrima* Fowler, B. C. A., p. 25; Tab. 2, figs. 14, 14a.

El Tumbador (Champion, 1894).

Membracis foliata Linnaeus

1705. Figure, Merian, Ins. Surinam, Pl. 5.
1767. *Cicada foliata* Linnaeus, Syst. Nat., 2: 705.
1775. *Membracis foliata* Fabricius, Syst. Ent., 2: 675.
1780. *Cicada maculifolia* Stoll, Cigal., p. 17; Pl. 1, fig. 2.
1787. *Membracis flaveola* Fabricius, Mant. Ins., 2: 262.
1851. *Membracis celsa* Walker, List Hom. B. M., p. 475.
1851. *Membracis surgens* Walker, List Hom. B. M., p. 475.
1851. *Membracis expansa* Walker, List Hom. B. M., p. 475.
1858. *Membracis flexa* Walker, Ins. Saund., p. 58.
1920. *Membracis jessica* Goding, Membracidae of Ecuador, p. 34, fig. 1.

Guatemala (Salle).

Membracis mexicana Guerin

1838. *Membracis mexicana* Guerin, Icon. Reg. Anim., p. 364; Pl. 59, fig. 1.
1846. *Membracis stolida* Fairmaire, Rev. Memb., p. 248.
1858. *Membracis sex-maculata* Walker, Ins. Saund., p. 59.
1903. *Phyllotropis suffusa* Buckton, Mon. Memb., p. 38; Pl. 3, figs. 1, 1a.
1903. *Phyllotropis mexicana* Buckton, Mon. Memb., p. 41.

San Joaquin, Duenas, San Geronimo, Vera Paz, Mirandilla, San Isidro (Champion, 1894); Guatemala City (W. D. F., 1942); Guatemala (Funkhouser collection, collector unknown).

Philya minor Fowler

1894. *Philya minor* Fowler, B. C. A., p. 22; Tab. 2, figs. 9, 9a, 9b.

Cerro Zunil (Champion, 1894).

Notocera bituberculata Fowler

1894. *Pterygia bituberculata* Fowler, B. C. A., p. 24; Tab. 2, figs. 13, 13a.
1928. *Notocera bituberculata* Goding, Jour. N. Y. Ent. Soc., 36: 232.

San Juan, Chacoj, El Reposa (Champion, 1894).

Notocera cerviceps Fowler

1894. *Pterygia cerviceps* Fowler, B. C. A., p. 24; Tab. 2, figs. 12, 12a.
1928. *Notocera cerviceps* Goding, Jour. N. Y. Ent. Soc., 36: 233.

Teleman, Panima, Panzos, Vera Paz (Champion, 1894).

Notocera hispida Fairmaire

1846. *Pterygia hispida* Fairmaire, Rev. Memb., p. 265.
1928. *Notocera hispida* Goding, Jour. N. Y. Ent. Soc., 36: 233.

Guatemala (Fowler, 1924).

Scalmorphus reticulatus Fowler

1894. *Scalmorphus reticulatus* Fowler, B. C. A., p. 23; Tab. 2, figs. 11, 11a, 11b.

San Geronimo, Cerro Zunil (Champion, 1894).

Spongophorus affinis Fowler

1894. *Spongophorus affinis* Fowler, B. C. A., p. 29; Tab. 3, figs. 2, 2a.

Quiche Mts., Totonicapan (Champion, 1894).

Spongophorus ballista Germar

1835. *Hypsauchenia ballista* Germar, Revue Silberman, 3: 231.
1846. *Spongophorus ballista* Fairmaire, Rev. Memb., p. 261.
1864. *Spongophorus claviger* Stål, Hemiptera Mexicana, p. 268.
1869. *Spongophorus apicalis* Stål, Bid. Memb. Kan., p. 273.
1891. *Spongophorus brunneus* Fallou, Rev. Ent., 9: 254.

San Juan, El Tumbador, Cerro Zunil, San Isidro (Champion, 1894).

Spongophorus championi Fowler

1894. *Spongophorus championi* Fowler, B. C. A., p. 28; Tab. 3, figs. 1, 1a.

El Reposo, San Isidro (Champion, 1894).

Spongophorus inflatus Fowler

1894. *Spongophorus inflatus* Fowler, B. C. A., p. 30; Tab. 3, figs. 5, 5a-c.

San Geronimo (Champion, 1894).

Spongophorus robustulus Fowler

1894. *Spongophorus robustulus* Fowler, B. C. A., p. 29; Tab. 3, figs. 3, 3a.

Guatemala (Fowler, 1894); Duenas (Champion, 1894); Aceituno (Salvin).

Tylopelta gibbera Stål

1869. *Tropidoscyta gibbera* Stål, Hemiptera Fabriciana, 2: 46.
1894. *Tylopelta gibbera* Fowler, B. C. A., p. 15; Tab. 2, figs. 1, 1a.
1894. *Tropidoscyta americana* Goding, Catalogue of Membracidae, p. 469.

Chicam, San Geronimo, Vera Paz (Champion, 1894).

Subfamily **Hoplophorinae**

Alchisme grossa Fairmaire

1846. *Triquetra grossa* Fairmaire, Rev. Memb., p. 280.
1851. *Triquetra virgata* Walker, List of Hom. Brit. Mus., p. 522.
1851. *Triquetra virescens* Walker, List Hom. B. M., p. 522.
1858. *Umbonia terribilis* Walker, Ins. Saund., p. 66.
1894. *Triquetra obtusa* Fowler, Trans. Ent. Soc. Lond., p. 417.
1929. *Alchisme grossa* Goding, South American Membracidae, p. 208.

Cubilguitz, Vera Paz, El Tumbador, Cerro Zunil, Panajachel, Pampojilaj (Champion, 1894).

Metcalfiella cinerea Fairmaire

1846. *Hoplophora cinerea* Fairmaire, Rev. Memb., p. 272.
1927. *Hoplophorion cinerea* Funkhouser, Catalogue Membracidae, p. 82.
1929. *Metcalfiella cinerea* Goding, So. Amer. Memb., p. 201.

Teleman, Panzos, Vera Paz, Capetillo (Champion, 1894); Chichicastenango, Lake Atitlan, Antigua (W. D. F., 1942).

Metcalfiella disparipes Fowler

1894. *Hoplophora disparipes* Fowler, B. C. A., p. 40; Tab. 3, figs. 25, 25a.
1903. *Ochropepla disparipes* Buckton, Mon. Memb., p. 104.
1927. *Hoplophorion disparipes* Funkhouser, Cat. Memb., p. 83.
1929. *Metcalfiella disparipes* Goding, So. Amer. Memb., p. 201.

San Geronimo (Champion, 1894).

Metcalfiella monogramma Germar

1835. *Hoplophora monogramma* Germar, Rev. Silb., 3: 242.
1846. *Hoplophora sanguinosa* Fairmaire, Rev. Silb., p. 270.
1903. *Hoplophora apriformia* Buckton, Mon. Memb., p. 95.
1927. *Hoplophorion monogramma* Funkhouser, Cat. Memb., p. 84.
1929. *Metcalfiella monogramma* Goding, So. Amer. Memb., p. 210.

Cerro Zunil, (Champion, 1894); Chichicastenango, Lake Atitlan, Quetzeltenango (W. D. F., 1942).

Platycotis discreta Fowler

1894. *Platycotis discreta* Fowler, B. C. A., p. 42; Tab. 4, figs. 4, 4a, 4b.

San Joaquin, Cubalco, Vera Paz (Champion, 1894); Guatemala (Funkhouser collection, collector unknown).

Platycotis histrionica Stål

1864. *Hoplophora histrionica* Stål, Hem. Mex., p. 69.
1869. *Lophopelta histrionica* Stål, Hem. Fabr., 2: 37.
1894. *Platycotis histrionica* Fowler, B. C. A., p. 43; Tab. 4, figs. 5, 5a.

Cerro Zunil, San Geronimo (Champion, 1894).

Platycotis nigrorufa Walker

1858. *Hemiptycha nigrorufa* Walker, List. Hom. B. M. Suppl., p. 143.
1894. *Platycotis nigrorufa* Fowler, B. C. A., p. 43.

Quetzeltenango (Champion, 1894; W. D. F., 1942).

Umbonia crassicornis Amyot and Serville

1843. *Physoplia crassicornis* Amyot and Serville, Hemiptera, p. 453.
1846. *Umbonia orizimbo* Fairmaire, Rev. Memb., p. 277.
1846. *Umbonia crassicornis* Fairmaire, Rev. Memb., p. 275.
1851. *Physoplia media* Walker, List Hom. B. M., p. 516.
1858. *Umbonia decorata* Walker, List. Hom. B. M. Suppl., p. 3.
1858. *Umbonia picta* Walker, List. Hom. B. M. Suppl., p. 130.
1869. *Umbonia rectispina* Stål, Bid. Memb. Kan., p. 265.
1895. *Physoplia peracea* Griffini, Stud. Memb. Umbonia, p. 3.
1895. *Physoplia camerani* Griffinie, Stud. Memb. Umbonia, p. 3.

Lanquin, Cahabon, San Geronimo, Vera Paz, El Tumbador, Las Mercedes, Coatepeque, El Reposo, Paraiso, Cerro Zunil, San Isidro, Volcan de Atitlan (Champion, 1894); Lake Atitlan (W. D. F., 1942).

Umbonia reclinata Germar

1835. *Hoplophora reclinata* Germar, Rev. Silb., 3: 243.
1846. *Umbonia reclinata* Fairmaire, Rev. Memb., p. 276.
1854. *Umbonia funesta* Stål, Nya. Hem., p. 249.
1858. *Umbonia multiformis* Walker, List Hom. B. M. Suppl., p. 129.
1903. *Umbonia subclivata* Buckton, Mon. Memb., p. 88.

Guatemala (Salle); Lanquin, San Geronimo, Vera Paz (Champion, 1894); Chichicastenango (W. D. F., 1942).

Umbonia ermanni Griffini

1895. *Umbonia ermanni* Griffini, Stud. Memb., 10: 6.
1903. *Enchotype* (sic) *ermanni* Buckton, Mon. Memb., p. 106.

Chichicastenango (W. D. F., 1942).

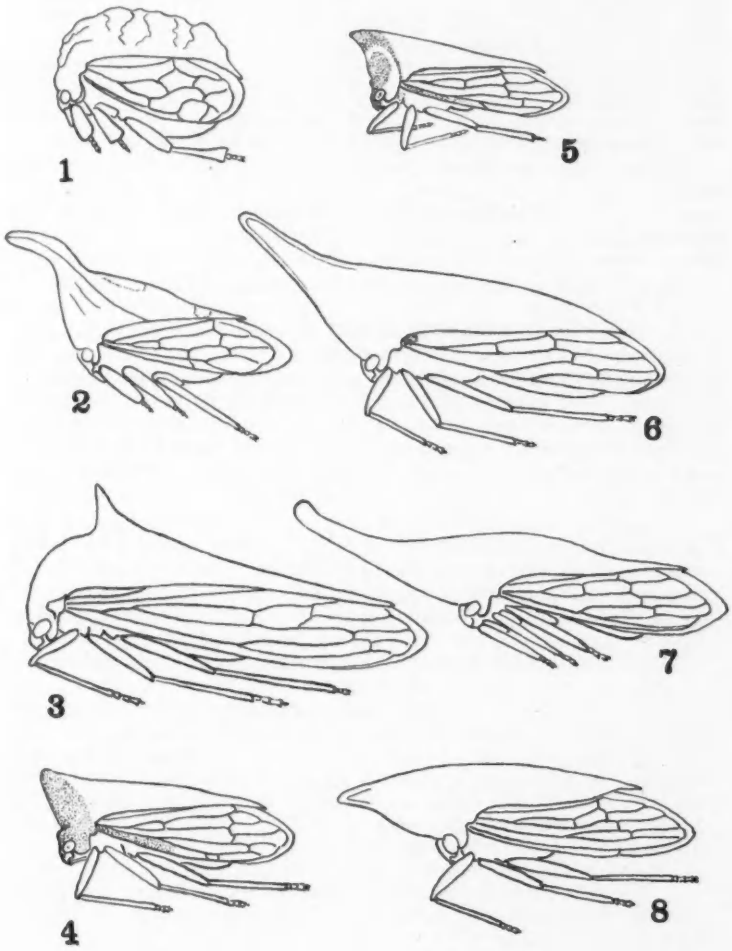


FIG. 1. *Bolbonota atitla* sp. nov. 2. *Enchenopa ansera* sp. nov. 3. *Umbonia antigua* sp. nov. 4. *Potnia maculata* sp. nov. 5. *Potnia brunneifrontis* sp. nov. 6. *Aconophora lutea* sp. nov. 7. *Aconophora coffea* sp. nov. 8. *Aconophora brevicornis* sp. nov.

Umbonia spinosa Fabricius

1766. *Cicada spinosa* Houttuyn, Nat. Hist., 1: 257.
1775. *Membracis spinosa* Fabricius, Syst. Ent., p. 675.
1792. *Membracis armata* Olivier, Enc. Meth., 7: 668.
1803. *Centrotus spinosis* Fabricius, Syst. Rhyng., p. 17.
1835. *Hoplophora spinosa* Germar, Rev. Silb., 3: 243.
1840. *Hemiptycha spinosa* Blanchard, Hem., 3: 183.
1835. *Umbonia spinosa* Burmeister, Handb. Ent., 2: 138.
1869. *Umbonia curvispina* Stål, Bid. Memb. Kan., p. 265.
1903. *Enchenotype* (sic) *curvispina* Buckton, Mon. Memb., p. 106.

Teleman, Vera Paz, San Isidro (Champion, 1894).

Umbonia nigrata Amyot and Serville

1843. *Physoplia nigrata* Amyot and Serville, Hem., p. 543.
1864. *Umbonia nigrata* Stål, Hem. Mex., p. 69.

Guatemala (Van Patton, date unknown; Funkhouser collection).

Umbonia antigua sp. nov.

(Figure 3)

Uniformly dark reddish-brown, very coarsely punctate, irregularly ridged, sparingly pubescent; dorsal horn short, sharp, erect, rising from behind the humeral angles; posterior process slender, sharp, not reaching the tips of tegmina; tegmina entirely exposed, brown, semiopaque; under surface and legs uniformly brown; hind tarsi much shorter than first two pairs.

Head subtriangular, roughly sculptured, finely punctate, densely pubescent; base weakly arcuate; eyes dark brown; ocelli large, amber-colored, equidistant from each other and from the eyes and situated about on a line drawn through centers of eyes; inferior margins of genae sinuate; clypeus swollen, extending for half its length below inferior margins of genae, tip suddenly acuminate, densely pilose.

Pronotum reddish-brown, coarsely punctate, sparsely pubescent, irregularly longitudinally ridged; dorsal horn extending upward and very slightly forward, about twice as long as its width at base, very sharp, arising from behind the humeral angles; metopidium low, sloping, twice as wide as high; median carina strongly percurrent; humeral angles strong, robust, triquerate, extending outward and slightly forward, as long as one-fourth of the distance between their bases; posterior process slender, acuminate, extending beyond the abdomen but not reaching tips of tegmina.

Tegmina entirely exposed; brown, translucent; veins very wide and heavy; base broadly opaque, coriaceous and punctate; five apical and four discoidal cells; third apical cell truncate at base, not petiolate; apical limbus broad.

Under surface of body uniformly brown; legs brown; femora cylindrical; tibiae triquerate and expanded at the distal ends; hind tarsi much shorter than other two pairs.

Length from front of head to tips of tegmina 8.5 mm.; width between tips of humeral angles 4.8 mm.

Described from a pair taken at Antigua, Guatemala, on February 26, 1942. The male is somewhat smaller and considerably darker than the female. Holotype female and allotype male in author's collection.

Umbonia immaculata sp. nov.

Large, uniformly dark green, without ridges, fossae, stripes or markings of any kind, coarsely punctate, not pubescent; dorsal horn heavy, erect, straight, sharp, arising from behind humeral angles; posterior process slender, reaching almost to tips of tegmina; tegmina entirely hyaline; under surface and legs entirely green, hind tarsi very short.

Head subquadrate, twice as wide as long, dark green, finely punctate; base arcuate and weakly sinuate; eyes green; ocelli prominent, brown, twice as far from the eyes as from each other and situated about on a line drawn through centers of eyes; inferior margins of genae rounded and flanged outward; clypeus extending for half its length below inferior margins of genae, tip pointed and pilose.

Pronotum dark green, coarsely punctate, not pubescent, without ridges, stripes or maculations; dorsal horn stout, erect, sharp, arising from behind humeral angles and extending directly upward; metopidium sloping above the head, as wide as high, smooth above base of head; humeral angles large, heavy, triangular blunt; median carina obsolete; posterior process long, slender, sharp, extending almost to tips of tegmina.

Tegmina hyaline; veins heavy; five apical and three discoidal cells; base narrowly opaque and punctate; apical limbus narrow.

Under surface dark green; legs fuscous; hind tarsi much shorter than other two pairs.

Length from front of head to tips of tegmina 13 mm.; width between tips of humeral angles 7.5 mm.

Described from a single female taken at San Jose, Guatemala, on March 2, 1942. Type in author's collection.

Potnia maculata sp. nov.

(Figure 4)

Yellow with prominent brown markings on metopidium, head and tegmina, coarsely punctate, not pubescent; pronotal horn porrect, short and rounded; posterior process tectiform, sharp, not reaching apices of tegmina; tegmina entirely exposed, hyaline mottled with brown; under surface of body brown; legs yellow.

Head subquadrate, wider than long, yellow with brown markings, finely punctate, sparingly pubescent; base weakly arcuate; eyes yellow-brown; ocelli inconspicuous, yellow, equidistant from each other and from the eyes and situated about on a line drawn through centers of eyes; inferior margins of genae sloping; clypeus extending for half its length below inferior margins of genae, tip pointed and pilose.

Pronotum yellow with the metopidium brown, coarsely punctate, not pubescent; pronotal horn very short and angulate, extending upward and forward, about as long as its width at base; dorsum nearly straight from top of horn to posterior extremity; metopidium wider than high, indented above the head, then sloping forward to tip of pronotal horn, brown, finely punctate; humeral angles large, swollen, conical, blunt; median carina percurrent; posterior process

tectiform, slender, sharp, extending to a point about half way between internal angles and tips of tegmina.

Tegmina hyaline, base and basal half of costal cell coriaceous, opaque, punctate and yellow; veins heavy; five apical and three discoidal cells; terminal cell truncate, not petiolate; apical limbus narrow.

Under surface of body fuscous; femora and tibiae yellow; tarsi yellow-brown; hind tarsi very short.

Length from front of head to tips of tegmina 5.2 mm.; width between humeral angles 2.6 mm.

Described from a single male taken in sweeping roadside vegetation near the shore of Lake Atitlan, Guatemala. Type in author's collection.

Potnia brunneifrontis sp. nov.

(Figure 5)

Small, green with brown markings on metopidium and head, finely punctate, not pubescent; pronotal horn short, porrect, pointed; posterior process slender, acuminate, not reaching tips of tegmina; tegmina wrinkled hyaline with strong brown veins; legs and under surface of body green.

Head subquadrate, very roughly sculptured, dark brown, finely punctate, sparingly pubsecent; base arcuate; eyes dark brown; ocelli amber-colored, twice as far from each other as from the eyes and situated somewhat above a line drawn through centers of eyes; inferior margins of genae sinuate; clypeus extending for half its length below inferior margins of genae, tip densely pilose.

Pronotum low, tectiform, green with dark brown markings in front, finely punctate, not pubescent; pronotal horn short, extending forward and upward above the head, about as long as its lateral width at base; dorsal margin sloping in nearly a straight line from pronotal horn to posterior process; metopidium broader than high, green with brown markings; humeral angles heavy, triangular, blunt; median carina percurrent; posterior process slender, tip sharp and extending to a point about half way from internal angles to tips of tegmina.

Tegmina entirely exposed; wrinkled hyaline; base narrowly opaque and punctate; five apical and three discoidal cells; terminal apical cell truncate, not petiolate; apical limbus narrow.

Under surface of body green marked with brown; femora and tibiae green; tarsi ferruginous; hind tarsi much shorter than other two pairs.

Length from front of head to tips of tegmina 4.3 mm.; width between humeral angles 2 mm.

Described from a single male taken at Chichicastenango, Guatemala, on February 13, 1942.

Subfamily **Darninae**

Aconophora caliginosa Walker

1858. *Aconophora caliginosa* Walker, List Hom. B. M. Suppl., p. 135.

Guatemala (Deby, 1858); Chacoj, Lanquin, Vera Paz, Coatepec (Champion, 1894); Quetzeltenango (W. D. F., 1942).

Aconophora disparicornis Fowler

1895. *Aconophora disparicornis* Fowler, B. C. A., p. 69; Tab. 5, figs. 17, 17a.

Chichicastenango (W. D. F., 1942); Guatemala (Funkhouser collection, collector and date unknown).

Aconophora ensata Fowler

1895. *Aconophora ensata* Fowler, B. C. A., p. 68; Tab. 5, figs. 14, 14a.

Guatemala (Salle).

Aconophora ferruginea Fowler

1895. *Aconophora ferruginea* Fowler, B. C. A., p. 69; Tab. 5, figs. 16, 16a.

Los Amates (Kellerman).

Aconophora laminata Fairmaire

1846. *Aconophora laminata* Fairmaire, Rev. Memb., p. 294.

Chichicastenango (W. D. F., 1942).

Aconophora laticornis Walker

1858. *Aconophora laticornis* Walker, List Hom. B. M. Suppl., p. 134.

Guatemala (Salle) (Van Patten); San Geronimo, Cerro Zunil, Totonicapan (Champion, 1894); Quetzeltenango (W. D. F., 1942).

Aconophora marginata Walker

1851. *Aconophora marginata* Walker, List Hom. B. M., p. 540.
1858. *Aconophora stabilis* Walker, List Hom. B. M. Suppl., p. 135.
1859. *Aconophora concolor* Dohrn, Cat. Hem., p. 79.
1869. *Aconophora nigra* Stål, Hem. Fabr., 2: 35.
1929. *Aconophora gracilicornis* Goding, So. Amer. Memb., p. 231.

Purula, San Geronimo, Vera Paz, Guatemala City (Champion, 1894); Guatemala City (W. D. F., 1942).

Aconophora mexicana Stål

1864. *Aconophora mexicana* Stål, Hem. Mex., p. 70.

Guatemala (Fowler, 1895).

Aconophora nigricornis Fowler

1895. *Aconophora nigricornis* Fowler, B. C. A., p. 64; Tab. 5, figs. 10, 10a.

Chicam, San Geronimo, Vera Paz (Champion, 1894).

Aconophora pallescens Stål

1869. *Aconophora pallescens* Stål, Hem. Fabr., 2: 35.

San Geronimo, Coban, Vera Paz (Champion, 1894).

Aconophora pubescens Walker

1858. *Aconophora pubescens* Walker, Ins. Saund., p. 70.
1878. *Aconophora spathata* Butler, Cist. Ent., 2: 347.
1928. *Guayquila pubescens* Goding, Jour. N. Y. Ent. Soc., 36: 225.

Rio Maria, Linda, San Geronimo (Champion, 1894); Guatemala (Funkhouser collection, collector and date unknown).

Aconophora sinanjensis Fowler

1895. *Aconophora sinanjensis* Fowler, B. C. A., p. 70; Tab. 3, figs. 20, 20a, 21.

Sinanja (Champion, 1894); Lake Atitla (W. D. F., 1942).

Aconophora temaxia Fowler

1895. *Aconophora temaxia* Fowler, B. C. A., p. 70.

Guatemala (Osborn, 1909).

Aconophora lutea sp. nov.

(Figure 6)

Entirely bright shining yellow without markings, finely punctate, not pubescent; pronotal horn porrect, flattened laterally, half as long as the body; posterior process heavy, reaching just to tip of abdomen but not reaching tips of tegmina; tegmina hyaline with black spot at base; under surface and legs yellow.

Head subquadrate, wider than long, yellow, finely punctate; base weakly arcuate; eyes yellow; ocelli yellow, equidistant from each other and from the eyes; inferior margins of genae sinuate; clypeus extending for half its length below inferior margins of genae, tip pilose.

Pronotum bright yellow, finely punctate, not pubescent; pronotal horn heavy, flattened laterally, margins foliaceous, extending upward and forward; dorsum rounded; metopidium sloping forward in front of head to base of pronotal horn; lateral angles small, triangular, blunt; median carina obsolete except on the horn where it is sharp and extended; posterior process tectiform, heavy, tip sharp and extending just to end of abdomen but not reaching tips of tegmina.

Tegmina hyaline; base broadly yellow, coriaceous and punctate, with a black spot just behind humeral angles; five apical and four discoidal cells; base of third apical cell truncate, not petiolate; apical limbus broad.

Under surface of body yellow; femora yellow marked with black; tibiae and tarsi yellow.

Length from front of head to tips of tegmina 6.5 mm.; length from eye to tip of horn 4 mm.; width between humeral angles 3 mm.

Described from a single male taken at San Jose, Guatemala, on March 2, 1942. Type in author's collection.

Aconophora coffea sp. nov.

(Figure 7)

Rich coffee-brown, finely punctate, sparingly pubescent; pronotal horn porrect, laterally compressed, slightly upturned at tip, half as long as body; posterior process slender, reaching well beyond tip of

abdomen but not to tips of tegmina; tegmina entirely brown; under surface and legs brown.

Head subquadrate, wider than long, finely punctate, sparsely pubescent; base arcuate; eyes brown; ocelli glassy, equidistant from each other and from the eyes; inferior margins of genae sloping; clypeus extending for half its length below inferior margins of genae, tip pilose.

Pronotum brown, finely punctate, sparsely pubescent; pronotal horn heavy, blunt, extending forward and upward, tip slightly upturned, margins flattened; dorsum convex; metopidium sloping forward from head to base of horn; median carina percurrent; posterior process slender, sharp, extending beyond end of abdomen but not reaching tips of tegmina.

Tegmina brown, translucent; base narrowly opaque and punctate; veins strong; five apical and four discoidal cells; terminal cell truncate, not petiolate; apical limbus broad.

Under surface brown; femora brown; tibiae and tarsi ferruginous.

Length from front of head to tips of tegmina 6 mm.; length from eye to tip of horn 4 mm.; width between humeral angles 2.8 mm.

Described from a single male taken on a small coffee tree in the patio of the Palace Hotel, Guatemala City, Guatemala, on March 7, 1942. Type in author's collection.

Aconophora brevicornis sp. nov.

(Figure 8)

Uniformly bright yellow, finely punctate, sparingly pubescent; pronotal horn very short, stout, laterally compressed, extending directly forward; dorsum regularly arcuate; posterior process suddenly acute, not reaching apex of tegmen; under surface and legs entirely pale yellow.

Head subquadrate, twice as wide as long, pale yellow, smooth, densely pubescent with short yellow hairs; base nearly straight; eyes yellow; ocelli small, yellow, opaque, nearer to each other than to the eyes and situated about on a line drawn through centers of eyes; inferior margins of genae strongly sinuate; clypeus extending for half its length below inferior margins of genae, tip rounded and densely pilose.

Pronotum entirely pale yellow, finely punctate, sparsely pubescent; pronotal horn short, heavy, blunt, anterior half compressed laterally, extending straight forward over the head; dorsum regularly but feebly arcuate from tip of horn to apex of posterior process; metopidium sloping in front of head to base of horn, wider than high; humeral angles short and rounded; median carina faintly percurrent; posterior process suddenly acute, tip reaching just beyond internal angles of tegmina.

Tegmina entirely free; yellowish hyaline with yellow veins; base broadly coriaceous, opaque and punctate; five apical and four discoidal cells; terminal apical cell truncate, not petiolate; apical limbus broad.

Under surface of body yellow; legs entirely yellow; femora cylindrical; tibiae triquerate.

Length from front of head to tips of tegmina 5.5 mm.; length from top of head to tip of horn 2.6 mm.; width between humeral angles 3 mm.

Described from a single female taken at Antigua, Guatemala. Type in author's collection.

Aspona cuneata Fowler

1894. *Aspona cuneata* Fowler, B. C. A., p. 51; Tab. 4, figs. 14, 14a, 14b.

Chichicastenango (W. D. F., 1942).

Aspona turgescens Fowler

1894. *Aspona turgescens* Fowler, B. C. A., p. 50; Tab. 4, figs. 12, 12a-c.

Cubilguitz, Vera Paz (Champion, 1894).

Cymbomorpha prasina Germar

1835. *Smilia prasina* Germar, Rev. Silb., 3: 234.
1846. *Smilia nigrofasciata* Fairmaire, Rev. Memb., p. 292.
1858. *Smilia lepida* Walker, List. Hom. B. M. Suppl., p. 133.
1869. *Aulacotropis prasina* Stål, Hem., 2: 34.
1869. *Cymbomorpha prasina* Stål, Bid. Memb. Kan., p. 260.

Cubilguitz, Vera Paz (Champion, 1894).

Darnis lateralis Fabricius

1801. *Membracis lateralis* Coquebert, Ill. Ins., 2: 78 (nom. nud.).
1803. *Darnis lateralis* Fabricius, Syst. Rhyng., 2: 27.

Guatemala (Funkhouser collection, collector and date unknown).

Darnoides affinis Fowler

1894. *Darnoides affinis* Fowler, B. C. A., p. 82; Tab. 6, figs. 14, 14a, 14b.

El Reposo (Champion, 1894).

Entaphius funebris Buckton

1903. *Entaphius funebris* Buckton, Mon. Memb., p. 134; Pl. 28, figs. 6, 6a.

San Geronimo (Buckton, 1903).

Hebeticoides acutus Fowler

1894. *Hebeticoides acutus* Fowler, B. C. A., p. 53; Tab. 4, figs. 17, 17a-d.

Panima, Vera Paz (Champion, 1894).

Heteronotus trinodosus Butler

1878. *Heteronotus trinodosus* Butler, Cist. Ent., 2: 357; Pl. 7, fig. 8.

Panzos, Vera Paz (Champion, 1894).

Hyphinoe asphaltina Fairmaire

1846. *Hemiptycha asphaltina* Fairmaire, Rev. Memb., p. 319; Pl. 6, fig. 20.
1858. *Hemiptycha apriformis* Walker, List Hom. B. M. Suppl., p. 144.
1858. *Hemiptycha pubescens* Walker, List Hom. B. M. Suppl., p. 144.
1869. *Hyphinoe asphaltina* Stål, Bid. Hem. Syst., p. 558.
1869. *Hyphinoe morio* Stål, Bid. Memb. Kan., p. 257.
1909. *Hyphonoe* (sic) *asphaltina* Osborn, Ohio Nat., 9: 458.

Perula, Senahu, El Tumbador, Volcan de Atitla, Capetillo (Champion, 1895); Guatemala (Osborn, 1909).

Hyphinoe bigutta Walker

1858. *Hemiptycha bigutta* Walker, List Hom. B. M. Suppl., p. 142.
1878. *Hyphinoe bigutta* Butler, Cist. Ent., 2: 245.

El Reposo, Pantaleon, Volcan de Atitlan (Champion, 1895).

Hyphinoe cuneata Germar

1835. *Hemiptycha cuneata* Germar, Rev. Silb., 3: 246.
1846. *Hemiptycha globiceps* Fairmaire, Rev. Memb., p. 319.
1867. *Hyphinoe cuneata* Stål, Bid. Hem. Syst., p. 558.

Guatemala (Van Patton).

Hyphinoe marginalis Fallou

1890. *Hyphinoe marginalis* Fallou, Rev. Ent., 9: 353.

Guatemala (Salle, 1890).

Hyphinoe tau Fowler

1895. *Hyphinoe tau* Fowler, B. C. A., p. 76; Tab. 6, figs. 1, 1a, 1b.
1903. *Hyphinoe subfusca* Buckton, Mon. Memb., p. 122.
1903. *Hyphinoe atitlana* Buckton, Mon. Memb., p. 122.
1930. *Ceresa subfusca* Goding, Amer. Mus. Novit., p. 18.

El Reposo, Volcan de Atitlan (Champion, 1895); Lake Atitlan (W. D. F., 1942; Costepeque (Funkhouser collection, collector unknown).

Hyphinoe ochracea Fowler

1895. *Hyphinoe ochracea* Fowler, B. C. A., p. 78; Tab. 6, figs. 8, 8a.

Guatemala (Mus. Roy. Belg.; Mus. Holm.).

Hyphinoe purulensis Fowler

1895. *Hyphinoe purulensis* Fowler, B. C. A., p. 77; Tab. 6, figs. 4, 4a, 4b, 5, 5a, 5b.

Purula, Sabo (Champion, 1895).

Procyrta intectus Fowler

1895. *Dysyncritus intectus* Fowler, B. C. A., p. 81; Tab. 6, figs. 13, 13a, 13b.
1927. *Procyrta intectus* Funkhouser, Cat. Memb., p. 153.

San Juan, Pantaleon (Champion, 1925).

Stictopelta acutula Fairmaire

1846. *Darnis acutula* Fairmaire, Rev. Memb., p. 481.
1846. *Darnis brevis* Fairmaire, Rev. Memb., p. 483.
1878. *Cryptoptera acutula* Butler, Cist. Ent., 2: 342.
1895. *Stictopelta acutula* Fowler, B. C. A., p. 60; Tab. 5, figs. 6, 6a, 6b.

Chicam, Cerro Zunil, Zapote (Champion, 1895).

Stictopelta assimilis Fowler

1895. *Stictopelta assimilis* Fowler, B. C. A., p. 57.

Duenas (Champion, 1895).

Stictopelta indeterminata Walker

1858. *Darnis indeterminata* Walker, List Hom. B. M. Suppl., p. 148.
1883. *Stictopelta luisae* Berg, Ann. Soc. Cien. Arg., 16: 289.
1895. *Stictopelta indeterminata* Fowler, B. C. A., p. 59; Tab. 5, figs. 5, 5a, 5b.

Teleman, Vera Paz (Champion, 1895).

Tomogonia vittatipennis Fairmaire

1846. *Smilia vittatipennis* Fairmaire, Rev. Memb., p. 293; Pl. 5, fig. 3.
1869. *Tomogonia vittatipennis* Stål, Bid. Memb. Kan., p. 258.

Guatemala (Signoret, 1895).

Subfamily **Tragopinae**

Tragopa testudina sp. nov.
(Figure 9)

Large, finely punctate, not pubescent; flavous with small irregular brown markings and with three large black spots on dorsum, one in front and one on each side; pronotum testudinate, arcuate, longer than broad; humeral angles auriculate; subhumeral projections flat and rounded; tegmina almost entirely hidden under pronotum; under surface flat and flavous.

Head subquadrate, twice as broad as long, tinged with red, roughly sculptured, not punctate, not pubescent; base weakly arcuate; eyes black; ocelli large, glassy, twice as far from each other as from the eyes and situated about on a line drawn through centers of eyes; inferior margins of genae very short and rounded; clypeus twice as broad as long, truncate, extending only slightly below inferior margins of genae.

Pronotum yellowish with irregular brown markings and with three large black spots, one on the anterior margin covering most of the metopidium and one on each side extending from the lateral margin almost to the median dorsal line; pronotum arcuate and covering the entire body and tegmina like the carapace of a turtle; longer than broad; finely punctate; not pubescent; metopidium twice as broad as high, black; median carina obsolete; humeral angles extended outward into triangular auriculate processes; subhumeral plates broad and flat, extending downward and outward almost as far as the humeral angles; no distinct posterior process.

Tegmina almost entirely concealed by the pronotum; exposed basal portion black; corium with two discoidal cells; apical limbus very broad and wrinkled.

Under surface yellowish marked with black; legs flavous.

Maximum length 5 mm.; width between humeral angles 4.8 mm.

Described from three specimens, one male and two females, all collected at Guatemala City, Guatemala, on March 7, 1942. Holotype female, allotype male, and paratype female, in author's collection.

Subfamily **Smiliinae**

Tribe **Ceresini**

Acutalis fusconervosa Fairmaire

1846. *Acutalis fusconervosa* Fairmaire, Rev. Memb., p. 498.

San Juan, Senahu, Las Mercedes, Panajachel (Champion, 1895); Guatemala (Osborn, 1909).

Ceresa nigrovittata Fowler

1895. *Ceresa nigrovittata* Fowler, B. C. A., p. 104; Tab. 7, figs. 12, 12a.

Sabo, Vera Paz (Champion, 1894).

Ceresa testacea Fairmaire

1846. *Ceresa testacea* Fairmaire, Rev. Memb., p. 284.
1851. *Ceresa alta* Walker, List Hom. B. M., p. 529.
1859. *Ceresa cavicornis* Stål, Freg. Eus. Rega Ins., p. 284.
1878. *Ceresa stalii* Butler, Cist. Ent., 2: 217.

La Tinta, Chicam, San Geronimo (Champion, 1895); Chichicastenango (W. D. F., 1942).

Ceresa vitulus Fabricius

1775. *Membracis vitulus* Fabricius, Syst. Ent., p. 677.
1803. *Centrotus vitulus* Fabricius, Syst. Rhyng., 4: 20.
1820. *Centrotus pallens* Germar, Mag. Ent., 3: 25.
1835. *Smilia vitulus* Burmeister, Handb. Ent., 2: 137.
1846. *Ceresa spinifera* Fairmaire, Rev. Memb., p. 284.
1858. *Ceresa curvilinea* Walker, List Hom. B. M. Suppl., p. 132.
1878. *Ceresa rufescens* Butler, Cist Ent., 2: 218.
1878. *Ceresa distans* Butler, Cist Ent., 2: 218.
1929. *Ceresa excisa* Goding, So. Amer. Memb., p. 261.

El Reposo (Champion, 1895).

Ceresa rubra sp. nov.

(Figure 10)

Large, bright red, coarsely punctate, not pubescent; suprahumerals short and blunt; posterior process sharp, reaching just beyond the base of the terminal cell of the tegmen; tegmina hyaline; under surface and legs reddish-yellow.

Head subtriangular, roughly sculptured, finely punctate; base feebly arcuate; eyes dark brown; ocelli large, amber-colored, equidistant from each other and from the eyes and situated well below a line drawn through centers of eyes; inferior margins of genae rounded and weakly sinuate; clypeus extending for half its length below inferior margins of genae, tip rounded and pilose.

Pronotum blood-red, brighter on the angles; strongly arcuate above, a deep semicircular depression on each side, coarsely punctate, not pubescent; metopidium broader than high, straight above the head and then rounded to top of dorsum; suprahumeral horns short, blunt, triangular, bright red; median carina strong and percurrent; posterior process suddenly acuminate, red, extending to a point just beyond the base of the third apical cell of the tegmen.

Tegmina hyaline; base narrowly opaque and punctate; four discoidal and five apical cells; terminal cell petiolate; apical margin very broad.

Legs and under surface of body light reddish-yellow; femora cylindrical; tibiae triquerate and spined; tarsi pilose; claws red.

Length from front of head to tips of tegmina 8 mm.; width between tips of suprahumerals 4.2 mm.

Described from four males, all collected at Chichicastenango, Guatemala, on February 20, 1942. Holotype and three paratypes in author's collection.

Ceresa viridilineata sp. nov.

(Figure 11)

Narrow-bodied, slender, coarsely punctate, sparingly pubescent; distinguished by two apple-green stripes on each side of pronotum; suprahumerals long, recurved, very sharp; posterior process very slender, reaching to base of terminal cell of tegmen; tegmina hyaline; legs and under surface testaceous.

Head subtriangular, smooth, not punctate, not pubescent, shining, testaceous; base arcuate in center; eyes black; ocelli large, amber-colored, somewhat nearer to each other than to the eyes and situated about on a line drawn through centers of eyes; inferior margins of genae sinuate; clypeus long and slender, extending for two-thirds its length below inferior margins of genae, tip rounded and pilose.

Pronotum testaceous with two bright green stripes on each side, one arcuate from the suprahumerals to the base of the posterior process, the other following the inferior margin of the pronotum; coarsely punctate, sparingly pubescent; metopidium broader than high, straight above the head; suprahumeral horns long, sharp and recurved, about as long as half the distance between their bases, extending outward and curving backward; median carina faintly percurrent; humeral angles triangular and blunt; posterior process very slender, sharp, extending as far as the base of the third apical cell of the tegmen.

Tegmina hyaline; base narrowly coriaceous and punctate; veins strong; five apical and four discoidal cells; apical limbus broad and wrinkled.

Legs and under surface of body uniformly testaceous; femora cylindrical; tibiae triquerate with black spines; tarsi pilose.

Length from front of head to tips of tegmina 7.8 mm.; width between tips of suprahumeral horns 4.5 mm.

Described from four specimens, one male and three females, all taken at Quetzeltenango, Guatemala, on February 16, 1942. Holotype male, allotype female, and two paratype females in author's collection.

Cyphonia clavata Fabricius

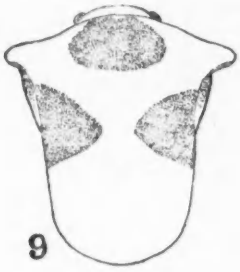
1780. Figure, Stoll, Cicag. Tab. 21, fig. 115.
1778. *Membracis clavata* Fabricius, Mant. Ins., 2: 264.
1799. *Centrotus clavatus* Coquebert, Ill. Icon., Tab. 18, fig. 5.
1821. *Membracis bulbifera* Germar, Mag. Ent., 4: 30.
1833. *Combophora clavata* Burmeister, Rev. Silb., 1: 230.
1843. *Cyphonia clavata* Amyot and Serville, Hem., p. 548.
1858. *Cyphonia hispida* Walker, List Hom. B. M. Suppl., p. 156.

Mirandilla (Champion, 1895); San Jose (W. D. F., 1942); Santa Lucia (Ohio State University collection, 1905).

Euritea munda Walker

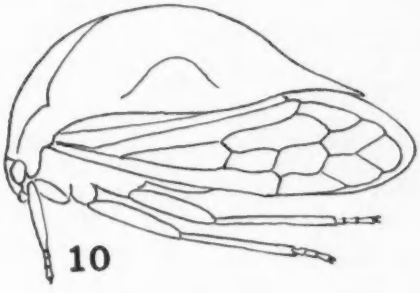
1858. *Parmula munda* Walker, List Hom. B. M. Suppl., p. 152.
1869. *Phacusa nigripes* Stål, Bid. Memb. Kan., p. 248.
1894. *Parmula nigripes* Goding, Cat. Memb., p. 411.
1895. *Euritea munda* Fowler, B. C. A., p. 113; Tab. 7, figs. 23, 23a.

Guatemala (Deby, 1858); Cubilguitz, Vera Paz, Volcan de Atitlan (Champion, 1895).



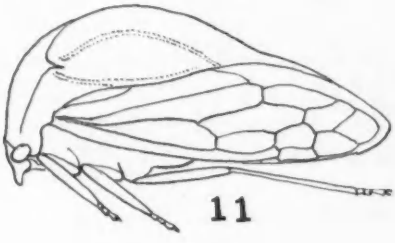
9

13

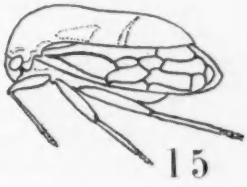


10

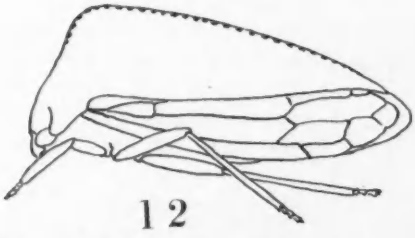
14



11



15



12

FIG. 9. *Tragopa testudina* sp. nov. 10. *Ceresa rubra* sp. nov. 11. *Ceresa viridilineata* sp. nov. 12. *Antianthe chichiana* sp. nov. 13. *Aphetea nigropicta* sp. nov. 14. *Amastris pacifica* sp. nov. 15. *Vanduzea mayana* sp. nov.

Micrutalis balteata Fairmaire

1846. *Acutalis balteata* Fairmaire, Rev. Memb., p. 496.
1895. *Micrutalis balteata* Fowler, B. C. A., p. 116.
1903. *Micrutalis ballista* (sic) Buckton, Mon. Memb., p. 219.

Cerro Zunil (Champion, 1895).

Micrutalis ephippium Burmeister

1836. *Tragopa ephippium* Burmeister, Rev. Silb., 4: 191.
1846. *Horiola ephippium* Fairmaire, Rev. Memb., p. 493.
1846. *Acutalis binaria* Fairmaire, Rev. Memb., p. 497.
1851. *Horiola ephippium* Walker, List Hom. B. M., p. 586.
1858. *Acutalis moesta* Stål, Rio Jan. Hem., 2: 33.
1859. *Horiola biplaga* Walker, Journ. Ent., 1: 5.
1883. *Acutalis variabilis* Berg, Ann. Soc. Cien. Arg., 16: 244.
1895. *Micrutalis moesta* Fowler, B. C. A., p. 85.
1907. *Micrutalis mutibilis* Baker, Can. Ent., 39: 116.
1927. *Micrutalis ephippium* Funkhouser, Cat. Memb., p. 217.
1929. *Micrutalis binaria* Goding, So. Amer. Memb., p. 293.

Guatemala City (Champion, 1895).

Micrutalis lugubrina Stål

1858. *Acutalis lugubrina* Stål, Rio Jan. Hem., 2: 32.
1895. *Micrutalis lugubrina* Fowler, B. C. A., p. 120.

Quetzeltenango (Champion, 1895); Guatemala (Osborn, 1909)

Parantonae dipteroides Fowler

1895. *Parantonae dipteroides* Fowler, B. C. A., p. 102; Tab. 7, figs. 10, 10a.

Aceytuno (Salvin, 1895).

Poppea affinis Fowler

1895. *Poppea affinis* Fowler, B. C. A., p. 100; Tab. 7, figs. 8, 8a, 8b.

Teleman (Champion, 1895).

Poppea reticulata Fowler

1895. *Poppea reticulata* Fowler, B. C. A., p. 101.

Panajachel (Champion, 1895).

Poppea rectispina Fairmaire

1846. *Cyphonia rectispina* Fairmaire, Rev. Memb., p. 502.
1867. *Poppea rectispina* Stål, Bid. Hem. Syst., p. 551.

San Juan, Cerro Zunil (Champion, 1895); Chichicastenango (W. D. F., 1942).

Poppea subrugosa Fowler

1895. *Poppea subrugosa* Fowler, B. C. A., p. 99; Tab. 7, figs. 5, 5a, 5b.

Cerro Zunil (Champion, 1895).

Poppea torva Fowler

1895. *Poppea torva* Fowler, B. C. A., p. 98; Tab. 7, figs. 4, 4a, 4b.

Las Mercedes (Champion, 1895).

Thrasymedes dubia Fowler

1895. *Phacusa dubia* Fowler, B. C. A., p. 112.
1927. *Thrasymedes dubia* Funkhouser, Cat. Memb., p. 232.

Cerro Zunil (Champion, 1895).

Thrasymedes major Fowler

1895. *Phacusa major* Fowler, B. C. A., p. 111; Tab. 7, figs. 20, 20a.
1927. *Thrasymedes major* Funkhouser, Cat. Memb., p. 232.

Volcan de Agua, San Geronimo (Champion, 1895).

Thrasymedes varieta Fowler

1895. *Phacusa varieta* Fowler, B. C. A., p. 111.
1927. *Thrasymedes varieta* Funkhouser, Cat. Memb., p. 233.

Quiche Mts., Totonicapam, San Geronimo (Champion, 1895).

Tribe **Telamonini**

Palonica satyrus Fowler

1896. *Telamona satyrus* Fowler, B. C. A., p. 145; Tab. 9, figs. 9, 9a.
1931. *Palonica satyrus* Ball, Ent. Amer., 12: 38.

San Geronimo, Quiche Mts. (Champion, 1895).

Tribe **Smiliini**

Antianthe expansa Germar

1835. *Hemiptycha expansa* Germar, Rev. Silb., 3: 245.
1835. *Hemiptycha cucullata* Burmeister, Hand. Ent., 2: 140.
1846. *Thelia expansa* Fairmaire, Rev. Memb., p. 309.
1859. *Thelia cucullata* Dohrn, Cat. Hem., p. 79.
1867. *Janthe expansa* Stål, Bid. Hem. Syst., p. 554.
1895. *Antianthe expansa* Fowler, B. C. A., p. 137.

Panzos, Cubilguitz, San Geronimo, San Isidro, Cerro Zunil, Guatemala City (Champion, 1895); Chichicastenango, Atitlan, Guatemala City (W. D. F., 1942).

Antianthe foliacea Stål

1864. *Smilia foliacea* Stål, Hem. Mex., p. 71.
1867. *Janthe foliacea* Stål, Bid. Hem. Syst., p. 554.
1895. *Antianthe foliacea* Fowler, B. C. A., p. 138.

San Juan, San Geronimo (Champion, 1895); Chichicastenango (W. D. F., 1942); Guatemala (Van Patton).

Antianthe humilis Buckton

1903. *Antianthe humilis* Buckton, Mon. Memb., p. 191; Pl. 41, fig. 4.

San Geronimo (Champion, 1895); Chichicastenango (W. D. F., 1942).

Antianthe reversa Walker

1858. *Thelia reversa* Walker, Ins. Saund., p. 72.

Antigua (W. D. F., 1942).

Antianthe viridissima Walker

1858. *Thelia viridissima* Walker, List. Hom. B. M. Suppl., p. 138.
1895. *Antianthe viridissima* Fowler, B. C. A., p. 138.

Chichicastenango (W. D. F., 1942); Guatemala (Van Patton).

Antianthe chichiana sp. nov.

(Figure 12)

Dark green, coarsely punctate, not pubescent; edge of dorsal crest margined with black spots; humeral angles large and auriculate; dorsum highest above humeral angles, then roundly sloping to apex; posterior process heavy, blunt, reaching almost to apex of tegmen; tegmina hyaline, inner third covered by pronotum; legs and under surface uniformly green.

Head triangular, green, coarsely punctate; base strongly sinuate; eyes brown; ocelli black, equidistant from each other and from the eyes and situated about on a line drawn through centers of eyes; inferior margins of genae straight; clypeus heavy, blunt, extending for half its length below inferior margins of genae and continuing the line of the face made by these margins.

Pronotum dark green, coarsely punctate, not pubescent; dorsum tectiform, rising abruptly above the head, highest above humeral angles, then arcuate to tip of posterior process; dorsal crest margined with black spots; metopidium sloping backward above head to top of crest; median carina strongly percurrent; humeral angles extended into heavy flat auriculate processes which extend directly outward, a little longer than broad and about as long as half the distance between their bases; posterior process heavy, blunt, tectiform, extending almost to tips of tegmina.

Tegmina hyaline; veins heavy; base narrowly opaque and coriaceous; inner third of tegmina concealed under pronotum; apical limbus broad; five apical and three discoidal cells; terminal apical cell petiolate.

Under surface light green; legs testaceous-green; femora cylindrical; tibiae triquerate and feebly spined; claws black.

Length from front of head to tips of tegmina 7.8 mm.; width between tips of humeral angles 5.5 mm.

Described from eight specimens, five males and three females, all taken at Chichicastenango, Guatemala, in February 1942. Holotype female, allotype male, and six paratypes in author's collection.

Aphetea inconspicua Fowler

1895. *Aphetea inconspicua* Fowler, B. C. A., p. 95; Tab. 6, figs. 25, 25a, 26, 26a.

Chacoj, Cahabon, Vera Paz (Champion, 1895).

Aphetea nigropicta sp. nov.

(Figure 13)

Small, light green with jet black markings, finely punctate, not pubescent; dorsum low, arcuate, three black spots on crest; sides of pronotum irregularly ridged and with a black line before the posterior

process; tegmina two-thirds concealed by pronotum, exposed part black except for a transparent spot in center; posterior process blunt and just reaching tips of tegmina; under surface green; legs green marked with black.

Head triangular, green punctate with black; roughly sculptured, not pubescent; base sinuate; eyes dark brown; ocelli large, prominent, glassy, equidistant from each other and from the eyes and situated on a line drawn through centers of eyes; inferior margins of genae rounded; clypeus extending for half its length beyond inferior margins of genae and continuing the line of the face made by these margins, tip blunt and pilose; under surface of head jet black.

Pronotum light green, finely punctate, not pubescent; dorsum low, arcuate, three black spots on margin of crest; sides of pronotum with three or four irregular carinae; a vertical black stripe at base of posterior process; posterior process short, blunt, extending just to tips of tegmina; metopidium low, broader than high; median carina sharp and strongly percurrent; humeral angles short, blunt, triangular.

Tegmina more than half concealed under the pronotum; concealed portion hyaline; exposed portion jet black except for a hyaline spot just behind center; venation almost indistinguishable because of black color; apical limbus very narrow.

Under surface green spotted with black; femora green; tibiae green with apices black; tarsi green; claws black.

Length from front of head to tips of tegmina 5 mm.; width between humeral angles 2.2 mm.

Described from three specimens, two females and one male, all taken at San Jose, Guatemala, on March 2, 1942. Holotype female, allotype male, and paratype female in author's collection.

Grandolobus vittatipennis Fowler

1896. *Cyrtolobus vittatipennis* Fowler, B. C. A., p. 142.

Quiche Mts. (Champion, 1895).

Ophiderma mus Fowler

1896. *Ophiderma mus* Fowler, B. C. A., p. 143; Tab. 9, figs. 3, 3a.

Quiche Mts. (Champion, 1895).

Tribe **Polyglyptini**

Adippe inaequalis Fowler

1896. *Adippe inaequalis* Fowler, B. C. A., p. 136; Tab. 8, figs. 20, 20a.

San Juan, Vera Paz (Champion, 1895).

Adippe zebrina Fairmaire

1846. *Oxygonia zebrina* Fairmaire, Rev. Memb., p. 305.
1858. *Oxygonia figurata* Walker, List Hom. B. M. Suppl., p. 137.
1867. *Adippe zebrina* Stål, Bid. Hem. Syst., p. 555.

El Tumbador, Las Mercedes, Purula (Champion, 1895).

Amastris funkhouseri Haviland

1925. *Amastris funkhouseri* Haviland, Zoologica, 6: 3; Pl. 3, fig. 9.

San Jose (W. D. F., 1942).

Amastris pacifica sp. nov.

(Figure 14)

Small, fuscous, mottled with dark brown and white, roughly sculptured, finely punctate, not pubescent; a deep indentation on each side of pronotum just below dorsal margin; a white stripe before posterior process; dorsum regularly arched, highest before middle; posterior process heavy, reaching beyond tegmina; two-thirds of tegmen covered by pronotum; basal area of costal margin of tegmen coriaceous and opaque; under surface and legs fuscous.

Head subtriangular, convex, finely punctate, yellow; base sinuate; eyes translucent white; ocelli prominent, white, twice as far from each other as from the eyes and situated about on a line drawn through centers of eyes; inferior margins of genae rounded; clypeus extending for half its length below margins of genae and continuing the line of the face made by these margins, tip rounded and pilose.

Pronotum tectiform, roughly sculptured; dorsum regularly arcuate, highest before middle; finely punctate, not pubescent; a deep brown depression on each side near dorsal margin; a brown arcuate fascium before this depression; a vertical white stripe across pronotum behind middle; metopidium vertical above head, as high as broad; median carina sharply percurrent; humeral angles prominent, triangular, blunt; posterior process heavy, acute, extending just beyond apices of tegmina.

Tegmina only one-third exposed below margins of pronotum; exposed portion opaque, coriaceous and punctate on basal two-thirds, hyaline on apical third; apical limbus very narrow.

Under surface of body fuscous; legs fuscous with apices of tibiae marked with brown.

Maximum length 4.2 mm.; width between humeral angles 2 mm.

Described from ten females and nine males, all collected at San Jose, Guatemala, on March 2, 1942. Holotype female, allotype male, and seventeen paratypes in author's collection.

Boethoos distinguenda Fowler

1895. *Parmula distinguenda* Fowler, B. C. A., p. 91; Tab. 6, figs. 21, 21a, 21b.
1925. *Boethoos distinguenda* Haviland, Zoologica VI: 3, p. 250.

Panima, Teleman, Cubilguitz (Champion, 1895); Guatemala (Funkhouser collection, collector unknown).

Entylia gemmata Germar

1818. *Membracis gemmata* Germar, Mag. Ent., 4: 16.
1835. *Entylia gemmata* Germar, Rev. Silb., 3: 248.
1846. *Entylia cornicula* Fairmaire, Rev. Memb., p. 300.
1851. *Entylia incisa* Walker, List Hom. B. M., p. 548.

San Joaquin, Vera Paz (Champion, 1895).

Entylia sinuata Fabricius

1798. *Membracis sinuata* Fabricius, Ent. Syst. Suppl., p. 513.
1798. *Membracis emarginata* Fabricius, Ent. Syst. Suppl., p. 513.
1833. *Darnis sinuata* Germar, Rev. Silb., 1: 78.
1835. *Hemiptycha sinuata* Burmeister, Handb. Ent., 2: 140.
1846. *Entylia sinuata* Fairmaire, Rev. Memb., p. 300.
1851. *Thelia sinuata* Walker, List Hom. B. M., p. 1144.
1877. *Entylia mira* Butler, Cist. Ent., 2: 212.
1896. *Entylia inaequalis* Fowler, B. C. A., p. 130.
1903. *Entylia oedipus* Buckton, Mon. Memb., p. 183.
1916. *Entylia emarginata* VanDuzee, Check List Hem., p. 62.

Guatemala (Butler, 1877); Senahu, San Juan, Chicam, San Geronimo, Las Mercedes, Zapote, Guatemala City (Champion, 1895); Guatemala City (W. D. F., 1942).

Polyglypta costata Burmeister

1835. *Polyglypta costata* Burmeister, Handb. Ent., 2: 142.
1846. *Polyglypta pilosa* Fairmaire, Rev. Memb., p. 296.
1846. *Polyglypta nigriventris* Fairmaire, Rev. Memb., p. 297.
1846. *Polyglypta viridimaculata* Fairmaire, Rev. Memb., p. 298.
1851. *Polyglypta interrupta* Walker, List Hom. B. M., p. 545.
1851. *Polyglypta straminea* Walker, List Hom. B. M., p. 544.
1858. *Polyglypta strigata* Walker, List Hom. B. M. Suppl., p. 136.
1859. *Polyglypta bogotensis* Dohrn, Cat. Hem., p. 79.
1877. *Polyglypta reflexa* Butler, Cist. Ent., 2: 207.
1880. *Polyglypta godmani* Distant, Ent. Month. Mag., 16: 11.

Guatemala (Salle, 1877); San Geronimo, El Jicaro, El Reposo, Las Mercedes, Cerro Zunil, Capetillo (Champion, 1895); San Jose (W. D. F., 1942).

Polyglypta dorsalis Burmeister

1836. *Polyglypta dorsalis* Burmeister, Rev. Silb., 4: 178.
1836. *Polyglypta maculata* Burmeister, Rev. Silb., 4: 178.
1836. *Polyglypta pallipes* Burmeister, Rev. Silb., 4: 179.
1843. *Polyglypta siculata* Amyot and Serville, Hem., p. 541.
1843. *Polyglypta flavomaculata* Amyot and Serville, Hem., p. 541.
1877. *Polyglypta hordacea* Butler, Cist. Ent., 2: 209.
1877. *Polyglypta fusca* Butler, Cist. Ent., 2: 209.
1877. *Polyglypta tricolor* Butler, Cist. Ent., 2: 209.

Guatemala (Salle, 1877); Chicam, San Joaquin, San Geronimo, Mirandilla, Capetillo (Champion, 1895); Guatemala City (W. D. F., 1942).

Polyglypta lineata Burmeister

1836. *Polyglypta lineata* Burmeister, Rev. Silb., p. 179.
1846. *Polyglypta tredecem-costata* Fairmaire, Rev. Memb., p. 299.
1858. *Polyglypta abbreviata* Walker, List Hom. B. M. Suppl., p. 136.

Guatemala (Salle, 1877); San Joaquin, Vera Paz (Champion, 1895).

Polyglypta nigella Fairmaire

1846. *Polyglypta nigella* Fairmaire, Rev. Memb., p. 298.

Guatemala (Funkhouser collection, collector and date unknown).

Polyglypta nigridorsis Fowler

1896. *Polyglypta nigridorsis* Fowler, B. C. A., p. 123; Tab. 8, figs. 4, 4a.

Guatemala (Mus. Roy. Belg.); San Juan, San Geronimo, Vera Paz (Champion, 1895); Masagua (W. D. F., 1942).

Polyglyptodes cucullatus Fowler

1896. *Polyglyptodes cucullatus* Fowler, B. C. A., p. 128; Tab. 8, figs. 10, 10a, 10b.

Guatemala City (Champion, 1895; W. D. F., 1942).

Polyglyptodes scaphiformis Fowler

1896. *Polyglyptodes scaphiformis* Fowler, B. C. A., p. 129; Tab. 8, figs. 11, 11a, 11b.

Cerro Zunil (Champion, 1895).

Vanduzea albifrons Fowler

1895. *Hypamastris albifrons* Fowler, B. C. A., p. 93; Tab. 6, figs. 24, 24a.
1923. *Vanduzea albifrons* VanDuzee, Calif. Acad. Sci., 12: 11.

San Geronimo (Champion, 1895).

Vanduzea segmentata Fowler

1895. *Hypamastris segmentata* Fowler, B. C. A., p. 93; Pl. 6, figs. 23, 23a, 23b.
1908. *Vanduzea segmentata* VanDuzee, Stud. N. A. Memb., p. 103.

El Tumbador, San Isidro (Champion, 1895).

Vanduzea mayana sp. nov.

(Figure 15)

Brown with white markings, finely punctate, densely pubescent; dorsum rounded, slightly depressed in center; posterior process reaching base of terminal cell of tegmen; tegmina partly concealed by pronotum, veins heavy and black; under surface brown and black; legs ferruginous, marked with black.

Head subquadrate, wider than long, black, smooth, not punctate nor pubescent; base nearly straight; eyes yellow with brown vertical bands; ocelli prominent, pearly, twice as far from each other as from the eyes and situated about on a line drawn through centers of eyes; a yellow spot under each ocellus; inferior margins of genae sloping, rounded; clypeus extending for one-third its length below inferior margins of genae, tip rounded and pilose.

Pronotum low, rounded, somewhat depressed in center, finely punctate, densely pubescent; anterior half dark brown, posterior half lighter; a white line on margins of humeral angles, a broad white band above humeral angles, a thin white transverse line extending from margin of pronotum upward just behind middle; sides of meso- and metathorax white; metopidium sloping, wider than high, a narrow white line above each eye; humeral angles short, triangular, blunt; median carina percurrent; posterior process heavy, blunt, extending to base of terminal cell of tegmen.

Tegmina half concealed under pronotum; hyaline with veins heavy and black; base narrowly coriaceous and punctate; five apical and four discoidal cells; base of third apical cell truncate; apical limbus broad.

Under surface of body black in front and light brown behind. Femora black; tibiae white with brown extremities; tarsi white with brown markings.

Length from front of head to tips of tegmina 4.2 mm.; width between humeral angles 2.2 mm.

Described from a single male taken at Chichicastenango, Guatemala, on February 23, 1942. Type in author's collection.

Subfamily **Centrotinae**

Campylocentrus brevicornis Fowler

1896. *Campylocentrus brevicornis* Fowler, B. C. A., p. 151; Tab. 9, figs. 13, 13a.

Sinanja, Vera Paz (Champion, 1895).

Campylocentrus curvidens Fairmaire

1846. *Centrotus curvidens* Fairmaire, Rev. Memb., p. 515.
1846. *Centrotus subspinosus* Fairmaire, Rev. Memb., p. 519.
1866. *Acanthopes curvidens* Stål, Hem. Afr., 4: 89.
1894. *Campylocentrus subspinosus* Goding, Cat. Memb. N. A., p. 473.
1896. *Sphaerocentrus curvidens* Fowler, B. C. A., p. 154; Tab. 9, figs. 17, 17a, 17b.

Coban, San Geronimo, El Reposo, Las Mercedes, San Isidro, Pantaleon (Champion, 1896).

Campylocentrus hamifer Fairmaire

1846. *Centrotus hamifer* Fairmaire, Rev. Memb., p. 512.
1858. *Centrotus niveiplaga* Walker, List. Hom. B. M. Suppl., p. 160.
1869. *Campylocentrus hamifer* Stål, Bid. Memb. Kan., p. 289.

Guatemala (Scherzer, 1851); Sabo, Cerro Zunil (Champion, 1896).

Campylocentrus vitreipennis Fowler

1896. *Campylocentrus vitreipennis* Fowler, B. C. A., p. 150.

Senahu, Vera Paz (Champion, 1896).

Endoiastus caviceps Fowler

1896. *Endoiastus caviceps* Fowler, B. C. A., p. 168; Tab. 10, figs. 16, 16a.

Panzos, Cubilguitz (Champion, 1896).

Gnamptocentrus cavipennis Fowler

1896. *Gnamptocentrus cavipennis* Fowler, B. C. A., p. 153; Tab. 9, figs. 15, 15a, 15b.
1903. *Campylocentrus cavipennis* Buckton, Mon. Memb., p. 242.

Sinanja, Vera Paz (Champion, 1896).

Gnamptocentrus sinuatus Fowler

1896. *Gnamptocentrus sinuatus* Fowler, B. C. A., p. 152.
1903. *Campylocentrus sinuatus* Buckton, Mon. Memb., p. 242.

Cubilguitz, San Juan, El Tumbador, Las Mercedes, Cerro Zunil, Zapota (Champion, 1896).

Microcentrus pileatus Fowler

1896. *Phaulocentrus pileatus* Fowler, B. C. A., p. 159; Tab. 10, figs. 1, 1a.
1927. *Microcentrus pileatus* Funkhouser, Cat. Memb., p. 445.

San Geronimo (Champion, 1896).

Microcentrus proximus Fowler

1896. *Phaulocentrus proximus* Fowler, B. C. A., p. 160; Tab. 10, figs. 2, 2a.
1927. *Microcentrus proximus* Funkhouser, Cat. Memb., p. 445.

Cerro Zunil (Champion, 1896).

Smerdalea horrescens Fowler

1896. *Smerdalea horrescens* Fowler, B. C. A., p. 163; Tab. 10, figs. 7, 7a, 7b.

Panzos, Vera Paz (Champion, 1896).

Tolania obtusa Fowler

1896. *Tolania obtusa* Fowler, B. C. A., p. 166; Tab. 10, figs. 14, 14a.

Sinanja, Cubilguitz (Champion, 1896).

Tolania opponens Walker

1858. *Centrotus opponens* Walker, List Hom. B. M. Suppl., p. 159.
1896. *Tolania opponens* Fowler, B. C. A., p. 166.

Sinanja, Chicam, Cubilguitz (Champion, 1896).

THE ECOLOGY OF THE ORTHOPTERA AND DERMAPTERA OF THE GEORGE RESERVE, MICHIGAN, by IRVING J. CANTRALL. Pages 1–182, 10 plates, 3 text figures, and 2 maps; 6⅞ x 10 inches, paper bound. Miscellaneous Publications, Museum of Zoology, University of Michigan, No. 54. Published by UNIVERSITY OF MICHIGAN PRESS, Ann Arbor, Michigan. 1943. Price, $1.50.

This paper presents the results of a three-year study of an area of about two square miles in Livingston County, Michigan. The study was made to determine the species present, their habitat relationships, the seasonal changes in their populations, to develop a classification of the orthopteran habitats, and to acquire information on the natural history of the species in the area.

The author's treatment of this subject may be indicated by the table of contents: Introduction (pp. 11–14), Methods of Study (pp. 15–26), Description of the Area (pp. 27–33), The Orthopteran Habitats of the Reserve (pp. 34–57), Seasonal Relationships of the Orthoptera (pp. 58–66, Tables II–XI), Annotated List of Orthoptera and Dermaptera (pp. 67–175), Summary and Conclusions (pp. 176–177), References (pp. 177–182), and Plates (I–X, twenty photographs of habitats in the Reserve).

The environments of the George Reserve are described in terms of their physiographic, pedologic, and phytologic characteristics, which are correlated with species distributions. The orthopteran habitats are classified into three major types: xeric (two habitats in the upland grasslands), mesoxeric (two habitats in the upland woodlands), and hydric (eight habitats in marsh, swamp, and bog); several strata are recognized, which extend through two or more habitats.

One species of Dermaptera and 75 species and races of Orthoptera (including four new to Michigan) are recorded from the area. The habitat relationships of these species are discussed in detail, and the occurrence of each species in different habitats is classified as characteristic, sporadic, or erratic, on the basis of the permanency of its occupation of the habitat. Some species were found to be restricted to particular habitats or strata, and others were found to shift with the seasonal progression; many species were found to spread as erratics into non-characteristic habitats, especially in the fall. The relative abundance of the orthopteran populations, which was estimated from extensive field observations and collecting, is recorded on a five-term scale (abundant, common, numerous, occasional, or rare). A large amount of data on the life history, seasonal relations, breeding habits, song, etc., is given in the accounts of individual species.

This is a very comprehensive treatment of the subject. The author has presented in a clear and concise form a considerable amount of data on orthopteran ecology obtained by field and laboratory observations. This paper should be of interest not only to orthopterists, but to all entomologists interested in ecology. Entomological literature would be greatly enriched by more papers like this one.—D. J. B.

SOME VITAMIN REQUIREMENTS OF BLACK CARPET BEETLES, ATTAGENUS (?) SPP.

(Coleoptera: Dermestidae)

WARREN MOORE,[1]
Bon Air, Va.

Nutritionists are using numerous pure chemicals and purified substances in studying the nutrition of vertebrates. Additional nutrilites have been discovered by micro-biologists. It was believed that black carpet beetle larvae could be fed most of the substances which have been used in studying the nutrition of other organisms.

A study of the growth of the larvae in synthetic rations was begun in January, 1941. The insects came from pure cultures of our two species.[2] Some seven hundred growth studies have been made to date, but many of them have only served to indicate defects in my technique. Growth is determined not only by the chemical composition of the ration, but is influenced also by physical factors such as hardness, dustiness, and moisture content. These factors, in turn, are influenced by chemical composition. For example, at low humidity, the addition of 15% glycerol resulted in increased growth, the ration being less dusty and presumably having a higher moisture content. At high humidity, the ration containing glycerol became sticky and the insects grew faster when glycerol was omitted. In studying five of the vitamins, I have succeeded in preparing rations which seemed to differ only in chemical composition. Some experiments with these rations will be reported in this paper.

VITAMIN TESTS

The ration had approximately the following composition:

1.	Vitamin-free casein (Labco)	350.0 mg.
2.	Corn starch (Argo)	150.0 mg.
3.	Mineral mixture	15.0 mg.
4.	Benzene extract of liver[3]	0.025 c. c.
5.	Extracted fish meal	30.0 mg.
6.	Glycerol	70.0 mg.
7.	Choline chloride	1.000 mg.
8.	Nicotinic acid (Niacin)	0.050 mg.
9.	Thiamin Chloride (B_1)	0.007 mg.
10.	Riboflavin (B_2)	0.005 mg.
11.	Pyridoxin HCl (B_6)	0.006 mg.
12.	Ca pantothenate (Pan)	0.020 mg.
13.	Mead's Oil of Percomorpheum	5.0 mg.
14.	Cystine	2.0 mg.
15.	Glucosamine HCl	2.0 mg.

[1]Acknowledgments are due to Dr. J. C. Forbes and to Dr. W. A. Peabody, of Richmond, for advice and for materials, and to M. B. Moore for handling the cultures and other help.

[2]Moore, Warren and Moore, M. B. 1942. Two species of black carpet beetle. J. Ec. Ent., 35: 288.

[3]100 c. c. contained the extract from 100 gm. of liver meal.

16. Urea..... 2.0 mg.
17. Phytin..... 1.0 mg.
18. B-alanine..... 0.012 mg.
19. p-aminobenzoic acid..... 0.020 mg.

Of the ingredients, the first twelve are present because they seemed to be beneficial, the remaining seven for theoretical reasons. Newly-hatched larvae of both species grew slowly on this ration for at least seven weeks. When one of the vitamins was omitted, a mixture resulted which seemed not to differ physically from the complete mixture. A missing vitamin was restored by adding its alcoholic solution, mixing, and heating to 100° C.

TABLE I

INFLUENCE OF FIVE VITAMINS ON THE GROWTH OF BLACK CARPET BEETLE LARVAE (YELLOWS)

Number and weight in milligrams of the insects. ****indicates when the missing vitamin was restored.

ELAPSED TIME IN WEEKS	MISSING VITAMINS											
	B_1		B_6		B_2		Nicotinic Acid		Panto-thenic Acid		None	
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
0	25	(1.)	25	(1.)	25	(1.)	25	(1.)	25	(1.)	25	(1.)
3	25	5.6	25	5.7	14	2.5	25	3.4	7	1.5	22	6.1
4	24	7.1	25	7.5	13 **	2.5 **	25 **	3.4 **	7	1.7	22	8.5
5	23	8.0	25	8.9	12	3.7	22	5.1	5	1.6	23	13.6
6	22	8.3	24	9.4	12	6.5	22	7.7	5	2.2	23	14.8
7	21 **	8.2 **	23 **	9.4 **	11	9.0	22	10.0	5 **	2.2 **	23	18.1
8	21	9.6	21	12.0	.....	.....	.....	.....	5	3.4	23	20.5
9	20	11.7	21	12.4	11	11.2	21	13.0	5	4.4	23	20.6
10	.....	.....	19	14.2	.....	.....	.....	.....	.....	.....	23	21.7

Table I shows a comparison of the growth and mortality of newly-hatched "yellows," *Attagenus? piceus?* 220 mg. of feed and 25 larvae were placed in each of six shell vials. They were kept in an incubator at 86°–87° F. and about 60 per cent R. H., except when they were removed for observation and manipulation. At intervals, the larvae were separated by sifting, counted, weighed, and returned to the food and vials from which they had been removed. When growth ceased in a vial, the missing vitamin was restored by adding a drop of its alcoholic solution.

A similar test with newly-hatched larvae of the "blacks" yielded similar results. When any one of the five vitamins was omitted, growth ceased in four to six weeks. When the missing vitamin was restored, growth was resumed. In the complete ration, growth continued throughout the experiment.

The data indicate that newly-hatched larvae of neither species can grow on diets which do not supply thiamin, riboflavin, pyridoxin, nicotinic acid, and pantothenic acid. B-alanine did not replace pantothenic acid. Whether other vitamin fragments are active has not been determined.

It will be noted that the insects receiving all five vitamins were heavier at each successive weighing. When any of the five vitamins was omitted, growth ceased sooner or later, and was resumed when the missing vitamin was supplied.

SUMMARY

Newly-hatched larvae of two species of black carpet beetle grew slowly in a synthetic ration containing vitamin-free casein, starch, minerals, extracted fish meal, benzene extract of liver, glycerol, choline, nicotinic acid, thiamin, riboflavin, pyridoxin, and pantothenic acid. When any one of the last five was omitted, growth ceased sooner or later and was resumed when the missing vitamin was supplied.

ECOLOGICAL CROP GEOGRAPHY, by KARL H. W. KLAGES. Pages xviii+615, 108 figures, 6 x 9½ inches. Published by THE MACMILLAN CO., New York, N. Y. 1942. Price, $4.50.

Entomologists who are aware of the importance of an understanding of plant ecology to an understanding of insect problems will find in this book a clear, comprehensive, and up-to-date treatment of the principles underlying the ecology and distribution of crop plants. Although the book was written primarily for students of agronomy, it will fill a long-felt need by biologists, economists, geographers, and others who are interested in the problems of crop ecology.

The book is divided into four parts. Part I (pp. 1–70), The Social Environment of Crop Plants, discusses the economic, political, social, technological, and historical factors which influence crop plants; these factors are either omitted or treated but slightly in most plant ecology texts. Part II (pp. 71–131), The Physiological Environment of Crop Plants, deals with the general aspects of the interactions of the plant with environmental factors (external factors in relation to development, physiological limits, crop yields and the ecological optimum, and adaptation). Part III (pp. 132–338), The Ecological Factors, contains detailed discussions of moisture and moisture relationships, temperature, light, air movement, edaphic and physiographic factors, and contains a chapter on climate classifications. Part IV (pp. 339–594), The Geographical Distribution of Crop Plants, emphasizes the physiological growth requirements of the crop plants discussed rather than the statistical phases of the subject.

The material in this book is well organized and clearly presented. At the end of each chapter is a list of selected references, and at the end of the book is an author index and a subject index. The statistical data cited (and shown by numerous tables and maps) were obtained from the United States Department of Agriculture, Agricultural Statistics, 1940.

We heartily recommend this book to entomologists and others who are interested in the phase of plant ecology which has to do with crop plants.—D. J. B.

THE TAXONOMY OF THE FALSE SCORPION GENUS SYNSPHYRONUS WITH REMARKS ON THE SPORADIC LOSS OF STABILITY IN GENERALLY CONSTANT MORPHOLOGICAL CHARACTERS

(Arachnida: Chelonethida)

JOSEPH C. CHAMBERLIN,[1]
Forest Grove, Oregon

The genus *Synsphyronus* Chamberlin was erected in 1930 (Ann. and Mag. Nat. Hist. (10), 5 : 609, 616–617) to accommodate an unusual species of the family Garypidae which differed primarily from other members of the group in having the metatarsus and tarsus of the legs secondarily fused to form a typical miotarsus. At the time, it was pointed out that, in spite of this unusual character, the genus was undoubtedly truly referable to the family Garypidae on the basis of every other morphological character definitive of that group. In spite of this, Beier in 1932 (Das Tierreich, 57 : 238) elevated the genus to family rank (Synsphyronidae) and removed it from the superfamily Garypoidea[2] to the Feaelloidea. Consideration of the following tabular summary of the normal characteristics of these two superfamilies will clearly reveal the untenability of Beier's disposition of this genus. In every character but the invariable presence of a normal, two-segmented tarsus, *Synsphyronus* agrees with the characters itemized under the heading Garypoidea.

GARYPOIDEA	FEAELLOIDEA
Tarsus two-segmented.	Tarsus one-segmented.
Carapacal alae or abdominal pleural plates absent.	Either carapacal alae or abdominal pleural plates present.
Venom apparatus present in both fingers.	Venom apparatus completely lacking.
Femoral articulation of leg IV a strongly oblique symphysis.	Femoral articulation of leg IV freely mobile as in leg I.
Leg I structurally strongly differentiated from leg IV.	Leg I superficially scarcely differentiated from leg IV.
Lamina exterior present.	Lamina exterior absent.
Posterior maxillary lyrifissure present.	Posterior maxillary lyrifissure absent.
Anus terminal or at most subventral; the eleventh tergite distinct.	Anus ventral; the eleventh tergite fused with the eleventh sternite to form a ventral circumanal plate.

[1]Associate Entomologist, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, Forest Grove, Oregon.

[2]Beier in his monograph of 1932 (*op. cit.*) took occasion to rename all the suborders and superfamilies proposed by Chamberlin in 1929 and 1931 without any significant change in the concept of the categories so considered. Thus the suborder Heterosphyronida of Chamberlin became the suborder Chthoniinea Beier, the Diplosphyronida the Neobisiinea Beier, and the Monosphyronida the Cheliferinea Beier. In the case of the superfamilies a change in the termination of the name from *-oidea* to *-ides* (e. g., Chthonioidea to Chthoniides) was taken as the occasion for the erection of six "new" superfamilies. The justification

Finally, the accession of additional material representing two new species, hereinafter described, provides specimens which clearly show every step in gradation between the normally differentiated metatarsus and telotarsus of the usual garypid leg and the miotarsus of *Synsphyronus*.

At the time of its original description (Chamberlin, *op. cit.*) it was pointed out that *Synsphyronus* was closely related, in a generic sense, to *Maorigarypus*. This is borne out by the present study, which indicates the necessity of so redefining the generic limits of *Synsphyronus* as to involve the reduction of *Maorigarypus* either to synonomy or to subgeneric status. The latter course is here followed. Although both these names were published at the same time, *Synsphyronus* has page priority and will therefore stand as the name of the genus.

The instability of the tarsal segmentation in this genus, a character which is otherwise subordinally constant, is of interest, but is by no means unique in arthropod morphology. For example, the number of tarsal segments has been employed as a primary character in the division of the coleopterous subfamily Aleocharinae into tribes. Nevertheless, as shown by Chamberlin and Ferris (Pan-Pacific Ent. 5 (3) : 142, 1929), material of the single species *Diaulota brevipes* Casey yielded individuals with clearly four-segmented tarsi while in others the tarsi were as clearly five-segmented. Furthermore, gradations between these two extremes were available (Chamberlin and Ferris, *op. cit.*, p. 160, fig. 3E, 3G).

As a further example illustrating the sporadic instability of a generally constant characteristic, we may note that the movable finger of all chelonethids characteristically bears but a single seta (the galeal seta). Rarely two or three galeal setae may occur teratologically in individual specimens but never consistently except in the five species comprising the genus *Ellingsenius* (Cheliferidae, Cheliferinae) and in the unique species of the genus *Corosoma* (Chernetidae). In these two unrelated genera three galeal setae are normally present.

Such examples could be indefinitely multiplied and some must occur to most workers familiar with almost any extensive group.

This sporadic break-down of generally constant characters provides certain discouraging but nevertheless interesting features in the problems of taxonomy and emphasizes the need of classifications based on other than single characters, at least if a phylogenetically natural grouping is to be maintained. On the other hand, such a break-down must not be construed as proof that the character in question is of general instability elsewhere, and hence not to be regarded as reliable in any group. A character which may be of such constancy in many groups as actually to define categories of family or superfamily rank may be of only generic or specific value in other groups such as the present genus.

It is of further interest to note that in *Synsphyronus* the presence or absence of certain tactile setae of the chela is likewise generically unstable

---

for this action has never been published but the synonymy of the names so proposed, with those previously validated by the writer, is self-evident. The use of these names should therefore be eliminated from future taxonomic literature. There is already sufficient difficulty in achieving nomenclatorial stability without the introduction and use of a parallel series of names for identical taxonomic categories of whatever rank.

and of no more than specific value, whereas in most chelonethids the number and pattern of these setae are of generic or even greater constancy.

SUPERFAMILY **Garypoidea** Chamberlin

Family **Garypidae** Hansen

Subfamily **Garypinae** Simon

Genus **Synsphyronus** Chamberlin

1930. *Synsphyronus* + *Maorigarypus* Chamberlin, Ann. and Mag. Nat. Hist. (10) 5: 616–617.
1931. *Synsphyronus* + *Maorigarypus* Chamberlin, Stanford Univ. Pubs., Univ. Ser., Biol. Sci. 7 (1): 135, 153, 155, 208, 215, and 228 (figs.).
1932. *Synsphyronus* Chamberlin + *Synsphyronidae* Beier + *Maorigarypus* Chamberlin, Beier, Das Tierreich, 57: 238 and 226.

Orthotype.—*Synsphyronus paradoxus* Chamberlin.

Distribution.—New Zealand and Australia.

Diagnosis (emended).—Garypine genus of typical facies most closely allied to *Anagarypus* Chamberlin. Carapace of usual form; transverse furrows absent or at most a posterior furrow very weakly developed; eyes large and conspicuous and about 3.5–4 ocular diameters from anterior margin (figs. 4, 6). Arolium extending beyond tarsal claws (figs. 12, 13); vestitural setae straight and distinctly to prominently clavate (figs. 5, 14); tergites with a marginal series of 4–10 setae and 8–16 large and relatively conspicuous lyrifissures; tergite 1 entire, 2–10 divided by a narrow stripe, 11 entire or partially divided; basifemur of legs I and II subequal to or slightly longer than telofemur (figs. 15, 16); femoral articulation of legs I and II semimobile (figs. 15, 16); tarsal segmentation variable; some species with a miotarsus, others with metatarsus and telotarsus distinct (figs. 18, 19, 20); all gradations between the two and single segmented tarsus occurring rarely on the same specimen (especially in *Synsphyronus* (*S.*) *mimetus* and *S.* (*M.*) *mimulus*, spp. nov.). Chaetotaxy (fig. 9) of chela generically unstable, the total number of tactile setae varying from 8 to 9 on the fixed finger and from 1 to 3 on the movable finger. Seta T of movable finger always present; SB and ST present or absent; B always absent. The eight tactile setae of the interior and exterior series present and, in addition, an accessory tactile seta ("A") sometimes occurring slightly caudad of IT (fig. 9). In as far as it is not affected by the loss of setae, the chaetotaxy of the various included species conforms closely to the theoretically complete pattern shown herewith (fig. 9). Only seta B of the movable finger seems to be consistently absent in all species. The chaetotaxy differs from that of *Anagarypus* in that seta EST in that genus is only slightly proximad of IT but is much posterior thereto in *Synsphyronus* (IT nearer to EST than to ET in *Anagarypus* but much closer to ET than to EST in *Synsphyronus*). Chelicera of usual facies; galeal seta apical in position and opposite distal attachment of serrula exterior (fig. 11);

seta *sb* nearly opposite seta *is* and together with *ls* forming a compact triangular group (fig. 11); setae *b* and *es* both present and normal in position; setae *b* and *sb* unusually short. Flagellum with three blades (figs. 10, 11). Hand of chela broader than deep. Derm of palps, carapace, tergites, and legs reticulately rugose, the reticulations occurring in a more or less conspicuous, hyaline pseudoderm which is separable from the true derm but which normally invests it closely as a tunic (figs. 5, 8, 17, 25–30). When removed (mechanically or otherwise) the true derm is nearly or quite smooth although usually retaining the appearance of the reticulations, on tergites and carapace, as smooth tessellations. The setae are not removed by peeling the pseudoderm, either mechanically or by boiling in caustic potash. No pores or glands have been observed from which this pseudoderm might be derived. It is generally thin or absent from around the setae. The presence of this pseudoderm, which has earlier been noted by With, is not confined to *Synsphyronus* but also occurs in *Anagarypus*, at least.

Remarks.—It is to be noted that the interpretation of the homologies of the tactile setae of the chela in this genus as given in this study (see figs. 9, 21–24) differs from that indicated by Chamberlin in 1931 (*op. cit.*, p. 141, fig. 37S), which is now regarded as in error.

The measurements and proportions given in connection with the specific descriptions are exclusive of the pseudoderm.

The species *Garypus hansenii* With from Tasmania was assigned to this genus in 1932 by Beier (*op. cit.*). It differs widely, however, in a number of important respects which, I believe, are sufficient to justify its removal from the group. A new genus, *Idiogarypus*, q. v., is therefore erected at this time for its reception.

Excluding *hansenii*, five species are currently referable to the genus. These may be separated by means of the following key:

1. Tarsi single-segmented (point of intertarsal union sometimes visible as a more or less definite constriction which is, however, nonmembranous), (Subgenus *Synsphyronus*).....2
   Tarsi two-segmented (occasionally one or two of the legs of certain specimens will have the intertarsal articulation vestigial, in which case three tactile setae occur on the movable finger of the chela), (subgenus *Maorigarypus*)...3
2. Movable finger with two tactile setae; anterior eyes strongly elliptical; robust species, femur 3.46–3.60 times as long as broad.....**paradoxus**
   Movable finger with but a single tactile seta; anterior eyes circular; slender species, femur 3.8–4.1 times as long as broad.....**mimetus**
3. Movable finger of chela with one, fixed finger with nine, tactile setae.....4
   Movable finger with three, fixed finger with eight, tactile setae.....**mimulus**
4. Tibia of female 2.8 (male 2.6) times as long as broad; femur of female 4.3 (male 4.1) times as long as broad; female galea with three terminal branches; male 3.4, female 4.0 mm. long; median tergites bordered by 6–8 clavate setae; palpal chela much more darkly pigmented than the other segments and blackish in color; green coloration not evident on preserved specimens at least; from New Zealand.....**melanochelatus**
   Tibia of female about 2.5 times as long as broad; femur of female 4.0 times as long as broad; female galea with two terminal branches; female 2.8 mm. long; median tergites bordered by four clavate setae; light green in color—not noted whether this was in life and whether or not it is retained after preservation; palps presumable unicolorous (not specifically noted as otherwise); from Australia.....**viridis**

Subgenus **Synsphyronus** Chamberlin

Previous references.—Heretofore considered of full generic rank. See literature citations under generic heading.

Orthotype.—*Synsphyronus paradoxus* Chamberlin.

Diagnosis.—Tarsal segments of legs secondarily fused into a more or less typical miotarsus.

Synsphyronus (Synsphyronus) paradoxus Chamberlin

Figures 2, 24, 29, 30

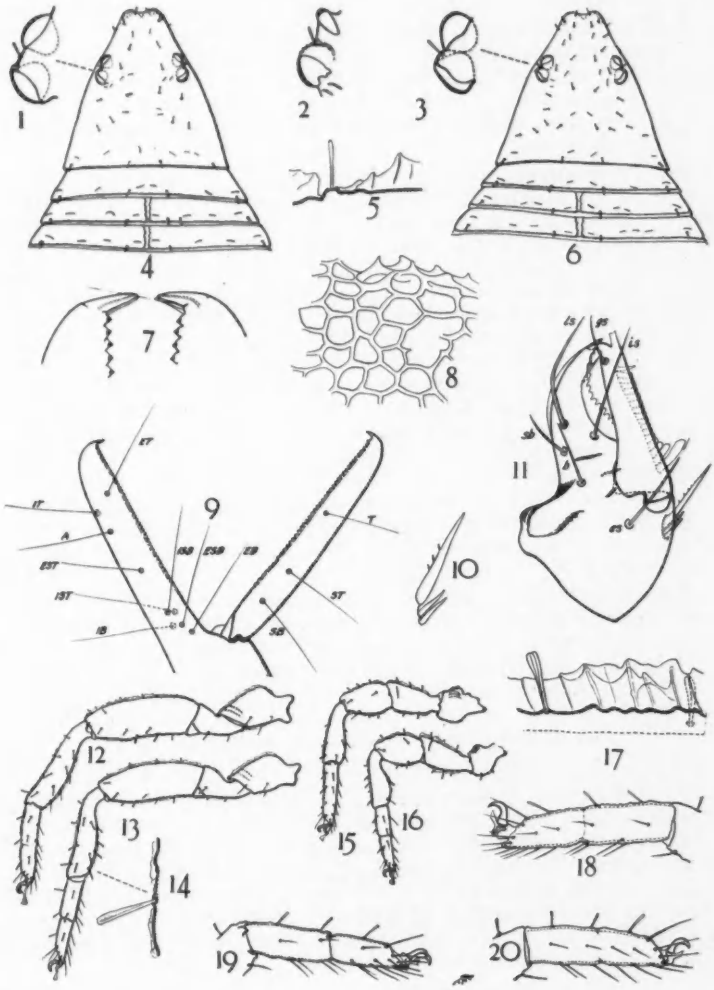
1930. *S. paradoxus* Chamberlin, Ann. and Mag. Nat. Hist. (10) 5: 617 (tf. 1-BB, CC legs I and IV and 3 V palpal seta).
1931. *S. paradoxus* Chamberlin, Chamberlin, Stanford Univ. Pubs., Univ. Ser., Biol. Sci. 7 (1): 52, fig. 11, I (ventral aspect of cheliceral foramina); 122, fig. 29 E (pedipalp); 164, figs. 44, D, C, (legs I and IV); 177, figs. 47, M, P (setae of tergite and pedipalp).
1932. *S. paradoxus* Chamberlin, Beier, Das Tierreich, 57: 238.
1937. *S. paradoxus* Chamberlin, Tubb, Roy. Soc. Victoria, Proc. (n. s.), 49: 412–419.

Diagnosis (addenda on basis of types).—Anterior eyes strongly elliptical rather than circular (fig. 2). Chaetotaxy of chelicera typical of subfamily; flagellum of three blades, the posterior two of which are much dwarfed. Serrula exterior with 15 teeth. Fixed finger of chelicera with three large, median, and two small, subapical, marginal teeth. Fixed finger of chela with 34, movable finger with 27, marginal teeth; in both cases the proximal 4–6 teeth are reduced and nearly obsolescent. Chaetotaxy of chela (fig. 24) conforming closely to the generic pattern as far as present; setae A, ST, and SB absent (fig. 24). Carapacal chaetotaxy 2–6 (30–34); median disc of carapace with a total of 10–14 setae; tergites 1–3 bordered by 6–8 setae while tergites 4–9 are bordered by 9 or 10 (generally the latter). Palpal form (male and female) as illustrated (figs. 29, 30).

Proportions.—The following appendicular proportions are those of the holotype and allotype (i. e., male and female), respectively. Palps:

EXPLANATION OF PLATE I

FIGURE 1, *Synsphyronus* (*Maorigarypus*) *mimulus*, eyes; 2, *S.* (*S.*) *paradoxus*, eyes (note elliptical form of anterior eye), (female 481.02002); 3, *S.* (*S.*) *mimetus*, eyes; 4, *S.* (*M.*) *mimulus*, carapace and anterior tergites (male 619.03008); 5, *S.* (*M.*) *mimulus*, hyaline pseudoderm and vestitural seta from palpal tibia (male 619.03001); 6, *S.* (*S.*) *mimetus*, carapace and anterior tergites (female 619.02005); 7, *S.* (*M.*) *mimulus*, tip of fingers of chela (movable and fixed fingers, left and right, respectively), (male 619.03003); 8, *S.* (*S.*) *mimetus*, hyaline pseudoderm showing reticulations (removed from palpal tibia) (male 619.02007); 9, *Synsphyronus*, pattern of hypothetically complete chaetotaxy of the chela, based on form of *S.* (*S.*) *mimetus*; 10, *S.* (*S.*) *mimetus*, flagellum (male 619.02008); 11, *S.* (*S.*) *mimetus*, chelicera; 12, *S.* (*S.*) *mimetus*, fourth leg; 13, *S.* (*M.*) *mimulus*, fourth leg; 14, *S.* (*M.*) *mimulus*, tibial seta from fourth leg; 15, *S.* (*S.*) *mimetus*, first leg; 16, *S.* (*M.*) *mimulus*, first leg (female 619.03002); 17, *S.* (*M.*) *mimulus*, hyaline pseudoderm and setae on exterior aspect of palpal femur (female 619.02004); 18, *S.* (*S.*) *mimetus*, fourth tarsus showing vestigial articulation between metatarsus and telotarsus (female 619.02004); 19, *S.* (*M.*) *mimulus*, fourth tarsus showing normal metatarsus and telotarsus; 20, *S.* (*S.*) *mimetus*, fourth tarsus showing suppression of intertarsal articulation with resultant formation of a typical miotarsus (male 619.02001).


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

Trochanter 1.14 times as long as broad; femur about as long as carapace, 3.46–3.60 times as long as broad; tibia about as long as hand and much shorter than femur, 2.47–2.39 times as long as broad; chela 3.42–3.45 times as long as broad; hand and fingers subequal in length; hand 1.77–1.71 times as long as broad. Leg IV: Femur (greatest length of both subsegments) 2.91–3.47 times as long as deep and longer than palpal tibia; tibia 3.38–3.67 times as long as deep; miotarsus 3.62–3.65 times as long as deep. Leg I: Femur (both subsegments) 2.57 times as long as deep; tibia 2.64–2.52 times as long as deep; miotarsus 3.54–3.45 times as long as deep.

Measurements (in mm.).—Male (holotype). Total length (KOH cleared) 2.67, abdominal breadth 1.4. Carapace 0.787 long, 0.902 broad posteriorly, 0.541 broad across eyes. Cucullus 0.213 long. Palps: Trochanter 0.336 by 0.295, femur 0.754 by 0.220, tibia 0.582 by 0.236; chela 1.123 by 0.328, hand 0.585 long, fingers 0.559 long. Leg I: Femur (both subsegments) 0.371 by 0.144, basifemur 0.180 long, telofemur 0.208 long, tibia 0.243 by 0.092, miotarsus 0.230 by 0.065. Leg IV: Femur (greatest length both subsegments) 0.609 by 0.208, tibia 0.377 by 0.112, miotarsus 0.297 by 0.082.

Female (allotype). Total length (KOH cleared) 2.96, abdominal breadth 1.6. Carapace 0.768 long, 1.00 broad posteriorly, and 0.51 broad across eyes. Cucullus 0.180 long. Palps: Trochanter, indet., femur 0.786 by 0.218, tibia 0.587 by 0.246, chela 1.189 by 0.344, hand 0.620 long, fingers 0.590 long. Leg I: Femur (both subsegments) 0.379 by 0.148; basifemur 0.180 long, telofemur 0.215 long, tibia 0.248 by 0.098, miotarsus 0.238 by 0.069. Leg IV: Femur (greatest length both subsegments) 0.643 by 0.185, tibia 0.403 by 0.110, miotarsus 0.312 by 0.085.

Remarks.—Known originally from a single collection of four specimens from an unknown habitat at Menindie, New South Wales, Australia. Tubb (*op. cit.*) has since recorded it as "abundant under stones on Lady Julia Percy Island, Victoria, Australia."

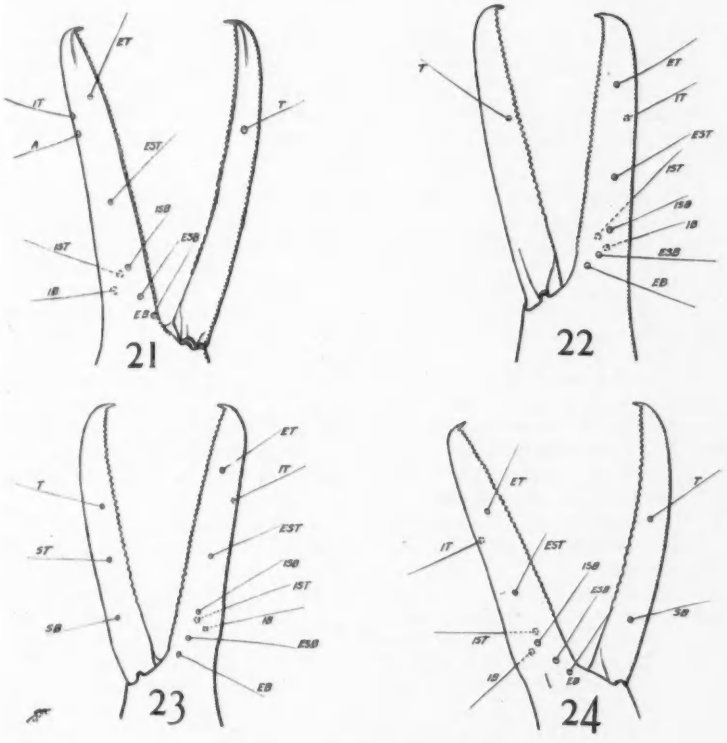
Types in author's collection.

Synsphyronus (Synsphyronus) mimetus, sp. nov.

Figures 3, 6, 8, 10, 11, 12, 15, 18, 20, 22, 25, 27

Type Material.—Holotype male (JC-619.02001), allotype female (JC-619.02004), and paratopotype males, females, and nymphs (JC-619.02002–3 and 5–40). Same collection data as for *Synsphyronus* (*Maorigarypus*) *mimulus*, sp. nov.: Corney Point, York Peninsula, South Australia, near Adelaide (cf. p. 496). Collected by Dr. S. Hirst and donated to the author. Types in author's collection; paratypes to be deposited in the United States National Museum and in the Museum of the University of Utah.

Diagnosis.—Excessively close in facies and appendicular proportions to *Synsphyronus* (*Maorigarypus*) *mimulus*, sp. nov. Serrula exterior of chelicera with 16–18 teeth; fixed finger with three large, submedian, and two small, subapical, teeth. Movable finger of chela with 35–40 (generally nearer the latter), fixed finger with



EXPLANATION OF PLATE II

FIGURE 21, *Synsphyronus* (*Maorigarypus*) *melanochelatus* (from Chamberlin, 1931; modified); 22, *S.* (*S.*) *mimetus* (male 619.02001); 23, *S.* (*M.*) *mimulus* (male 619.03003); 24, *S.* (*S.*) *paradoxus* (male 481.02001).

47–54, marginal teeth which are well developed on both fingers to the base. Chaetotaxy of chela conforming closely to generic pattern as far as present (fig. 22); setae A, ST, SB, and B lacking. Carapace of usual form (fig. 6); transverse furrows absent or vestigial; anterior eyes nearly circular (fig. 3); chaetotaxy 2–4 (30–34). Tergal scuta with a central darker spot. Tergites 1–3 bordered posteriorly by four, tergites 4–9 by six, clavate setae and about 14 large lyrifissures. Sternites bordered by six acute (or elongate clavate (latter on posterior segments)) setae and about 14 large lyrifissures. Coxal area of typical garypoid type (Chamberlin, Stanford Univ. Pubs., Univ. Ser., Biol. Sci. 7(1): 84, fig. 19-J, 1931) except that the maxillae are relatively somewhat shortened and there is a slight tendency for the trochanteral foramen of the forelegs to assume a more ventral position than usual. Palps as illustrated (figs. 25, 27).

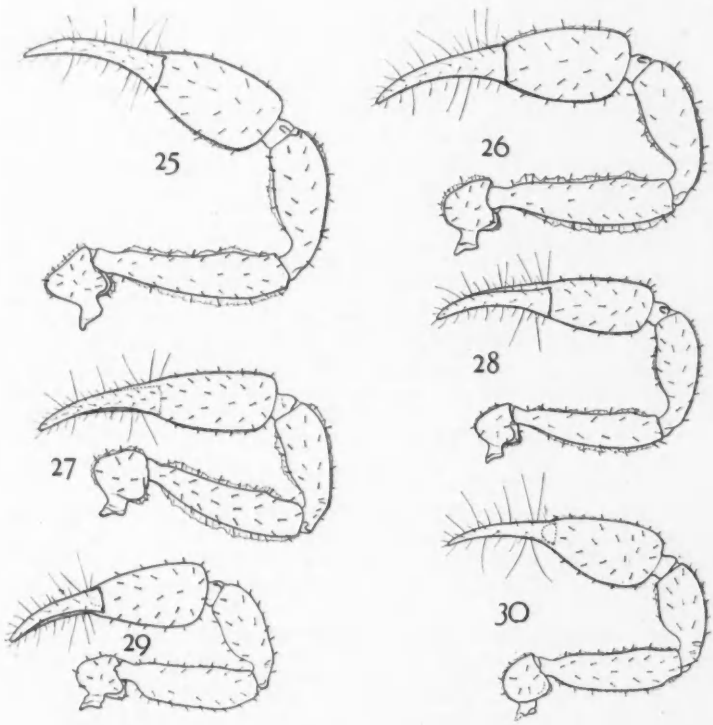
Proportions (limits of actually observed variation indicated).—Male: Trochanter 1.3–1.4 times as long as broad, femur 4.1 times as long as broad, tibia 2.7–2.8 times as long as broad, chela 3.8–4.2 times as long as broad, hand 1.8–2.1 times as long as broad, hand about equal to or slightly shorter than fingers. Female: Trochanter 1.3 times as long as broad, femur 3.9–4.0 times as long as broad, tibia 2.6–2.9 times as long as broad, chela 3.5–3.7 times as long as broad, hand 1.8–2.1 times as long as broad, hand shorter than fingers. Leg I (both sexes): Femur (both subsegments) 3.0–3.3 times as long as deep, tibia 2.8–3.0 times as long as deep, miotarsus 3.9–4.0 times as long as deep, basifemur slightly longer than telofemur. Telofemur deeper than basifemur. Leg IV (both sexes): Femur (greatest length both subsegments) 3.7–4.2 times as long as deep, tibia 4.3–4.7 times as long as deep, miotarsus 4.1–4.6 times as long as deep.

Constriction or pseudosuture of miotarsus of all legs (at point marking the fusion point of the two tarsal segments) submedian in position (figs. 18, 20).

Measurements (in mm.)—Male (holotype). Total length (KOH expanded) 2.79, abdominal width 1.6. Carapace 0.80 long, 0.935 broad posteriorly, and 0.517 broad across eyes. Cucullus 0.197 long. Palps: Trochanter 0.407 by 0.308, femur 0.918 by 0.226, tibia 0.695 by 0.253, chela 1.255 by 0.326, hand 0.604 long and 0.278 deep, fingers 0.671 long. Leg I: Femur (both subsegments) 0.453 by 0.148, tibia 0.290 by 0.098, miotarsus 0.271 by 0.069. Leg IV: Femur (greatest length both subsegments) 0.697 by 0.180, tibia 0.475 by 0.103, miotarsus 0.358 by 0.085.

Female (allotype). Total length (KOH cleared) 3.48, abdominal breadth 1.9. Carapace 0.92 long, 1.081 broad posteriorly, and 0.607 broad behind eyes. Cucullus 0.230 long. Palps: Trochanter 0.448 by 0.354, femur 1.046 by 0.261, tibia 0.804 by 0.279, chela 1.44 by 0.410, hand 0.689 long and 0.361 deep, fingers 0.772 long. Leg I: Femur (both subsegments) 0.522 by 0.157, tibia 0.328 by 0.110, miotarsus 0.315 by 0.080. Leg IV: Femur (greatest length both subsegments) 0.815 by 0.195, tibia 0.541 by 0.115, miotarsus 0.412 by 0.093.

Out of four specimens measured the following were the extremes (male and female) in the palpal measurements: Trochanter 0.407–0.448



EXPLANATION OF PLATE III

(All drawings to same scale.)

FIGURE 25, *Synsphyronus* (*Synsphyronus*) *mimetus*, ventral aspect of left pedipalp (female 619.02004); 26, *S.* (*Maorigarypus*) *mimulus*, ventral aspect of left pedipalp (female 619.03002); 27, *S.* (*S.*) *mimetus*, dorsal aspect of right pedipalp (male 619.02003); 28, *S.* (*M.*) *mimulus*, ventral aspect of left pedipalp (male 619.03001); 29, *S.* (*S.*) *paradoxus*, ventral aspect of left pedipalp (male holotype); 30, *S.* (*S.*) *paradoxus*, dorsal aspect of right pedipalp (female allotype).

by 0.303–0.354, femur 0.918–1.046 by 0.226–0.261, tibia 0.689–0.804 by 0.249–0.294, chela 1.255–1.446 by 0.310–0.410, hand 0.604–0.725 long, fingers 0.659–0.772. Total body length 2.79–3.48.

Remarks.—Disregarding the chaetotaxy of the chela and the presence or absence of the miotarsus, it is instructive to compare this form with the excessively similar *Synsphyronus* (*Maorigarypus*) *mimulus*. As will be noted in comparing the descriptions, aside from the features above mentioned, there is scarcely a sharply marked characteristic by which the two species may be separated. Palpal and pedal proportions especially are extremely close or identical. In the following couplet all the definite points of difference I have been able to find are contrasted:

1. Tarsi fused to form a miotarsus, showing at most a more or less definite constriction and suturelike marks at the point of the former articulation; movable finger with but a single tactile seta present (T); median disc of carapace with a total of 11–14 setae; tergites 4 and 5 with six border setae; palps slightly more robust than in the following species, chela of male 2.8–4.2, of female, 3.5–3.6 times as long as broad; miotarsi relatively stout, tarsi I 3.9–4.0 times, tarsi IV 4.1–4.6 times, as long as deep, **S. (S.) mimetus**

Tarsi plainly two-segmented, only rarely being fused to form a miotarsus (and then this does not affect all the legs); movable finger of chela with three tactile setae, B only lacking; median disc of carapace with 6–8 setae; tergites 4 and 5 with four border setae; palps more attenuate, chela of male 4.2–4.4 times, of female 3.5–3.8 times, as long as broad; tarsi more slender, measuring both segments as a miotarsus, tarsi I 4.2–4.6 times, tarsi IV 4.7–5.0 times, as long as deep..... **S. (M.) mimulus**

Subgenus **Maorigarypus** Chamberlin

Previous references.—Heretofore considered of full generic rank. See literature citations under the generic heading.

Orthotype.—*Maorigarypus melanochelatus* Chamberlin.

Diagnosis.—Tarsal segments of legs distinct, two in number.

Synsphyronus (**Maorigarypus**) **mimulus,** sp. nov.

Figures 1, 4, 5, 7, 13, 14, 16, 17, 19, 23, 26, 28

Type Material.—Holotype male (JC-619.03001), allotype female (JC-619.03002), and paratopotype male and female (JC-619.03003–28), all from the same collection vial labeled "Corney Point, York Peninsula, South Australia." This locality is near Adelaide (137° west longitude and 35° south latitude). Collected by Dr. S. Hirst, to whom I am indebted for this splendid collection. This material was included in the same vial which contained the type lot of *Synsphyronus* (*S.*) *mimetus*, sp. nov. All material is in the author's collection. Types in the author's collection; paratypes to be deposited in the United States National Museum and in the Museum of the University of Utah.

Diagnosis.—Excessively close in most respects to *Synsphyronus* (*S.*) *mimetus*, sp. nov. Serrula exterior of chelicera with about 18 teeth; fixed finger with three large, submedian, and two small, subapical, teeth. Movable finger of chela with 32–37 and fixed finger with 44–51 marginal teeth, which are well developed to the base of the fingers. Chaetotaxy of chela as illustrated (fig. 23), setae A and

B only absent. Carapace of usual form; posterior furrow absent or very weakly defined; chaetotaxy 2–4 (24). Tergites bordered by 12–14 large lyrifissures in addition to the marginal setae which number four on segments 1–5, four or five on segment 6, and six on segments 7–9. Sternites similarly bordered by about the same number of acute to slenderly clavate (latter on posterior segments) setae and about 14 lyrifissures. Coxal area as in *S.* (*S.*) ***mimetus***, sp. nov. (cf. p. 000). Palpal form as illustrated (figs. 26, 28).

Proportions (limits of actually observed variations indicated).—Male: Trochanter 1.2–1.4 times as long as broad, femur 3.8–4.2 times as long as broad, tibia 2.9–3.1 times as long as broad, chela 4.2–4.4 times as long as broad, hand 1.9–2.0 times as long as broad, hand shorter than fingers. Female: Trochanter 1.3–1.4 times as long as broad, femur 3.7–3.9 times as long as broad, tibia 2.6–2.9 times as long as broad, chela 3.5–3.8 times as long as broad, hand shorter than fingers (0.9x). Leg I (both sexes): Femur (both subsegments) 3.1–3.3 times as long as deep, basifemur slightly longer than telofemur, telofemur deeper than basifemur, tibia 2.9–3.1 times as long as deep, tarsus (both segments) 4.2–4.6 times as long as broad. Leg IV (both sexes): Femur (greatest length of both subsegments) 3.4–4.0 times as long as deep, tibia 3.8–4.3 times as long as deep, tarsus (both segments) 4.7–5.0 times as long as deep.

Basitarsus of all legs subequal in length to telotarsus.

Measurements (in mm.).—Male (holotype). Total length (KOH cleared) 2.22, abdominal breadth 1.25. Carapace 0.67 long, 0.82 broad posteriorly, and 0.44 wide behind eyes. Cucullus 0.197 long. Palps: Trochanter 0.339 by 0.251, femur 0.818 by 0.197, tibia 0.654 by 0.215, chela 1.191 by 0.272, hand 0.572 long and 0.251 deep, fingers 0.625 long. Leg I: Femur (both subsegments) 0.390 by 0.116, basifemur subequal to or slightly longer than telofemur, tibia 0.239 by 0.084, tarsus (both segments measured as a miotarsus) 0.284 by 0.064. Leg IV: Femur (greatest length of both subsegments) 0.574 by 0.143, tibia 0.366 by 0.095, tarsus (both segments measured as a miotarsus) 0.349 by 0.071.

Female (allotype). Total length (KOH cleared) 2.74, abdominal breadth, 1.6. Carapace 0.82 long, 1.00 broad posteriorly, and 0.52 broad behind eyes. Cucullus 0.230 long. Palps: Trochanter 0.425 by 0.320, femur 0.984 by 0.251, tibia 0.780 by 0.277, chela 1.424 by 0.379, hand 0.689 long and 0.343 deep, fingers 0.754 long. Leg I: Femur (both subsegments) 0.494 by 0.151, basifemur slightly longer than telofemur, telofemur deeper than basifemur, tibia 0.301 by 0.100, tarsus (both segments) 0.335 by 0.074. Leg IV: Femur (greatest length of both subsegments) 0.762 by 0.194, tibia 0.495 by 0.115, tarsus (both segments) 0.425 by 0.084.

Of four specimens measured, the following extremes in total length and palpal dimensions were found (male and female): Trochanter 0.339–0.425 by 0.251–0.320, femur 0.807–0.984 by 0.197–0.251, tibia 0.654–0.780 by 0.215–0.280, chela 1.166–1.424 by 0.272–0.384, hand 0.572–0.689 long, fingers 0.625–0.754 long. Total body length 2.22–2.80.

Remarks.—See discussion under *Synsphyronus* (*S.*) *mimetus*, sp. nov. (p. 496). The length of the basitarsus of the legs is subequal to that of the telotarsus.

Synsphyronus (Maorigarypus) melanochelatus (Chamberlin)

Figure 21

1930. *Maorigarypus melanochelatus* Chamberlin, Ann. and Mag. Nat. Hist. (10), 5: 617.

1931. *M. melanochelatus* Chamberlin, Chamberlin, Stanford Univ. Pubs., Univ. Ser., Biol. Sci., 7 (1): 141, fig. 37, *S* (chela); 160, fig. 42, *H* (arolium); 164, fig. 44, *E* (leg I).

1932. *M. melanochelatus* Chamberlin, Beier, Das Tierreich, 57: 226.

Diagnosis (addenda).—Chaetotaxy of chela as illustrated (fig. 21); setae ST, SB, and B absent; accessory seta A present. Movable finger of chela with 41, fixed finger with 53, marginal teeth. The following palpal proportions are from the holotype and allotype, respectively (male first, then female): Trochanter 1.33–1.37 times as long as broad, femur slightly longer than carapace and much longer than tibia, 4.07–4.26 times as long as broad, tibia 2.63–2.79 times as long as broad, chela 3.42–3.38 times as long as broad, hand 1.56–1.58 times as long as broad. Fingers distinctly longer than hand (1.19–1.14 times).

Measurements (in mm.).—Male (holotype). Total length (KOH cleared) 3.36, abdominal breadth indet. Carapace 1.01 long and 1.14 broad posteriorly. Cucullus 0.252 long. Palps: Trochanter 0.494 by 0.373, femur 1.120 by 0.275, tibia 0.858 by 0.327, chela 1.651 by 0.485 (0.448 deep), hand 0.756 long, fingers 0.896 long.

Female (allotype). Total length (KOH cleared) 4.01, abdominal breadth 2.05. Carapace 1.04 long by 1.26 broad posteriorly. Cucullus 0.261 long. Palps: Trochanter 0.513 by 0.373, femur 1.232 by 0.289, tibia 0.886 by 0.317, chela 1.732 by 0.513, hand 0.812 long; fingers 0.924 long.

Remarks.—Known only from the type collection from Ohakune, New Zealand. Types in the British Museum.

The homologies of the tactile seta of the chela as given by Chamberlin in 1931 (*op. cit.*, fig. 37S) are now believed to have been in error. The present interpretation of these homologies is shown in fig. 21.

Synsphyronus (Maorigarypus) viridis (Tubb)

1937. *Maorigarypus viridis* Tubb, Roy. Soc. Victoria Proc. (n. s.) 49: 412–413, tf. 1a (palp), 1b (tergal seta), and 1c (palpal seta).

Remarks.—Tubb does not give palpal measurements or detailed proportions. Neither does he figure or describe in detail the chaetotaxy and dentition of the chela. This makes it difficult to give a critical evaluation of his species which, however, seems sufficiently distinct.

Assuming that his illustration of the palp is accurate, the following approximate palpal proportions have been computed: Femur 4.0 times as long as broad, tibia 2.5 times as long as broad, chela 3.3 times as

long as broad. Tubb states that the tibia is 2.2 times as long as broad, but, unless his figure is in serious error, the true proportion on the basis of the key points employed in my studies is closer to 2.5 times, as indicated above. The discrepancy may be due to the employment of different key points in measuring the tibial length. The general appearance of the palps, as shown by Tubb's illustration, is typical of the genus.

The green coloration noted by Tubb and upon which the specific name is based cannot be properly evaluated as a taxonomic criterion until we know for certain whether it is really specific in nature and, if so, whether it is retained after preservation. In no specimens of the genus seen by me has any "distinctive" coloration been noted, but this does not indicate its absence in living or fresh material.

The tergal chaetotaxy as given by Tubb (four border setae each on segments 1–7 and eight each on segments 8–10), while distinctive, rather closely resembles that of *Synsphyronus* (*Maorigarypus*) *mimulus*, sp. nov.

The species was described from a single female taken under a stone near "Seal Bay, on Lady Julia Percy Island," Australia. The type is presumably deposited in the National Museum at Melbourne.

Idiogarypus gen. nov.

Orthotype.—*Garypus hansenii* With.

Occurrence.—Only the orthotype, from Tasmania, is known at present.

Diagnosis.—Garypine genus of typical facies most closely related to *Synsphyronus*. Carapace of usual form, posteriorly broader than long and lacking transverse furrows; eyes unusually reduced in size and, while situated well distad of median, about eight ocular diameters from anterior margin. Vestitural setae short and clavate; tergites with a marginal series of about six clavate setae on anterior segments; tergites 2 to 10 divided by a narrow stripe; tergite 1 entire, 11 partly divided. Basifemur of legs 1 and 2 subequal to, or slightly longer than, telofemur and with the interfemoral articulation semimobile only as in *Synsphyronus*. Tarsus with metatarsus and telotarsus distinct. Chaetotaxy of chela reduced, fixed finger with seven, movable finger with three, tactile setae. Exact chaetotaxal pattern unknown but setae IT, ISB, and IB distributed as in *Synsphyronus*.

Flagellum of three blades, of which the two posterior ones are much reduced; chaetotaxy of fixed finger of chelicera unknown but galeal seta of movable finger median in position and, if correctly illustrated, much caudad of terminal attachment of serrula exterior. Derm of palps, carapace, tergites, and legs densely reticulate, the reticulations occurring in a hyaline pseudoderm as in *Synsphyronus*.

Remarks.—The small eyes (eight ocular diameters from the anterior carapacal margin) and the medially placed galeal seta are unique and will at once distinguish *Idiogarypus* from all other genera in the family.

Idiogarypus hansenii (With)

1908. *Garypus hansenii* With, Vidensk. Meddel. Naturh. Foren. (6) 10: 12; pl. 1, f. 11 (chela); 12 (leg I); 13 (leg IV); 14 and 15 (femoral articulation); pl. 2, f. 1 (carapace); 2 (coxal and genital area); 3 (palp); and tf. 2 (flagellum and movable finger chelicera).

1930. *Garypus hanseni* With, Chamberlin, Ann. and Mag. Nat. Hist. (10) 5: 612. (Note on possible generic position.)

1932. *Maorigarypus hansenii* (With), Beier, Das Tierreich, 57: 226.

Remarks.—With's description of the chaetotaxy of the chela is incomplete but sufficient to indicate that it is very probably much the same as in *Synsphyronus* except for the absence of one of the exteriorly placed setae (probably ISB). He reports only seven setae on the fixed finger, three interiorly (as in *Synsphyronus*) and four exteriorly, these latter "arranged in a long row from base to near tip."

For convenience of reference, With's measurements (in mm.) of this species are reproduced herewith.

Length (male type) 3.59, abdominal breadth 1.87. Carapace ("cephalothorax") 0.99 long, 1.078 broad posteriorly, "anterior" breadth 0.242. Palps: Trochanter 0.420 by 0.380, femur 1.144 by 0.286, tibia 0.858 by 0.330, hand 0.782 by 0.420 (0.352 deep), fingers 0.924 long. Chela not measured by With, but on the basis of his figure it should be 1.73–1.75 long. Leg I: Basifemur 0.299 by 0.161, telofemur 0.261 by 0.175, tibia 0.356 by 0.120, basitarsus 0.204 by 0.088, telotarsus 0.168 by 0.074, tarsus (both segments), about 0.37 by 0.088. Leg. IV: Femur (both segments) 0.760 by 0.204, tibia 0.584 by 0.139, basitarsus 0.234 by 0.102, telotarsus 0.204 by 0.094, tarsus (both segments) about 0.44 by 0.102.

Remarks.—The species has thus far been recorded only from Tasmania. The unique type is in the British Museum.

ON YOUR OWN, by SAMUEL A. GRAHAM and EARL C. O'ROKE. Pages 150, 52 figs., 5¼ x 8 in., linen bound. 1943. Published by UNIVERSITY OF MINNESOTA PRESS, Minneapolis, Minn. Price $2.00.

The subtitle reads: "How To Take Care of Yourself in Wild Country, A Manual for Field and Service Men." At once we recommend this little volume to exploring entomologists. Few men know camping and the woods more intelligently than do its authors. However, their experience is in timber rather than desert. On vacation in ant and dragonfly country our copy will be taken in the family car.

The fourteen sections cover: 1. How to Meet Physical Extremes; 2. Minor Injuries; 3. Quicksand and Water Hazards; 4. Food in the Field; 5. Wild Edible Plants; 6. Wild Animals You Can Catch (and Animals You Should Avoid Eating); 7. Poisonous Plants; 8. Annoying or Dangerous Animals; 9. Insects and Other Irritating Pests; 10. How to Avoid Animal Diseases (Anthrax, Tularemia, Rabies, Spotted Fever, etc.); 11. Disease Carriers; 12. Parasites That Attack Man; 13. Equipment; 14. Do's to Remember; Don'ts to Remember.

On Your Own is, as it should be, a vivid book. The reader after visualizing the uncertainties of life outside of a well managed hospital wonders what he may run into in his yard and Victory Garden; and then the unguarded hours of sleep, a crack in the screen or a crevice under the window ledge.

On Your Own is a he-man's pioneering guide.—C. H. K.

NEW GENERA AND SPECIES OF ASTEIIDAE (DIPTERA), WITH A REVIEW OF THE FAMILY IN THE AMERICAS[1]

CURTIS W. SABROSKY,[2]
Michigan State College,
East Lansing, Michigan

Since the publication of a new western species of *Asteia* (Sabrosky, 1939, Pan-Pacific Ent., 15 : 165–167), a few additional specimens of the family have been found in material received for determination. As a result of the study of their proper status, the number of new points uncovered appeared to justify a summation of the family as a whole for the western hemisphere. Two genera and six species are described as new, one old generic name was found to be preoccupied, and one Palaearctic genus is recorded from North America for the first time. Because of the number of new combinations, a check list of the family for North and South America has been prepared according to the generic arrangement adopted here.

KEY TO THE GENERA OF ASTEIIDAE OF THE AMERICAS

1. Posterior crossvein absent; alula lacking 2
   Posterior crossvein present 4
2. Two pairs of dorsocentral bristles; first and second veins not ending together in the costa, leaving a short second costal sector (i. e., the section of costa between the tips of the first and second longitudinal veins) ..... **Asteia**
   One or three pairs of dorsocentral bristles; first and second veins ending together in the costa, thereby eliminating the second costal sector (fig. 1) 3
3. One pair of very long dorsocentral bristles, as long as the apical scutellars; no strong fronto-orbital bristle developed, though one weak upper orbital is slightly longer than the others; third antennal segment peculiarly bifurcate, with an irregularly serrate margin and numerous unusually long hairs (fig. 2) ..... **Loewimyia**
   Three pairs of dorsocentral bristles, the foremost pair anterior to the mesonotal suture; one pair of long, recurved fronto-orbital bristles, situated midway between the level of the median ocellus and the anterior margin of the front; third antennal segment not bifurcate and with margin entire, ... **Asteimyia**
4. Second longitudinal vein long, ending distad the middle of the wing; second costal sector decidedly longer than the first sector 5
   Second vein very short, abruptly recurved so as to end in the costa at or only slightly beyond the end of the first vein; second costal sector at most only one-third the length of the first sector 6
5. Arista bare or slightly pubescent; anterior crossvein proximad the junction of first vein with costa ..... **Leiomyza**
   Arista with a number of long rays; anterior crossvein distinctly distad the junction of first vein with costa ..... **Stenomicra**

---

[1]Journal Article No. 556 (n. s.) from the Michigan Agricultural Experiment Station.

[2]The writer wishes to express his appreciation to Mr. C. T. Greene of the U. S. National Museum and Mr. Nathan Banks of the Museum of Comparative Zoology for rechecking the types of Asteiidae at their respective institutions, and to Miss Elizabeth B. Bryant of the Museum of Comparative Zoology for examining the original publication and other literature for the exact use of *Sigaloëssa* in the Arachnida.

6. First and second longitudinal veins end together in the costa, eliminating the second costal sector; alula absent or nearly so, with few hairs; two pairs of dorsocentral bristles; discal cell short, the ultimate section of the fifth vein longer than the penultimate section of the fourth vein..... **Crepidohamma**
Second vein ends in costa distad the first vein, leaving a short but distinct second costal sector (figs. 4, 5); a small alula present, with a fringe of long hairs..... 7
7. One pair of dorsocentral bristles; third and fourth veins strongly converging, their apices less than the length of the hind crossvein apart; discal cell long and narrow, the fore crossvein adjoining it far before the middle, at the basal third of the cell; ultimate section of fifth vein shorter than the penultimate section of fourth vein (fig. 4)..... **Phlebosotera**
Two pairs of dorsocentrals; third and fourth veins not as close together at their apices, separated by the length of the hind crossvein or slightly more; discal cell shorter, though not as short as *Crepidohamma*, the fore crossvein at or slightly before the middle of the cell; ultimate section of fifth vein generally subequal the penultimate section of fourth vein (fig. 5).. **Astiosoma**

Genus **Stenomicra** Coquillett

The genus *Stenomicra* Coquillett has been referred to the Asteiidae by Hendel, and Malloch agreed that it was as close to that family as to the Drosophilidae, though with some resemblance to certain Anthomyzidae. The "families" of the Acalyptrate Diptera are separated on some seemingly slight differences and there is often disagreement on the location of intermediate genera. For my part, *Stenomicra* appears to be close to the Drosophilidae, but available material is not adequate for a detailed study at this time.

Genus **Asteia** Meigen

KEY TO THE AMERICAN SPECIES OF ASTEIA

1. Mesonotum yellow, marked with five pairs of black to reddish black spots which really represent four indistinct stripes and two supra-alar vittulae (western North America)..... **multipunctata**
Mesonotum glossy black..... 2
2. Mesopleura with a black stripe along the upper margin, connecting with the dark metanotum (Peru)..... **striatifrons**
Upper portion of the mesopleura yellow..... 3
3. Mesopleura entirely yellow; front brown posteriorly, becoming yellow on the anterior part (eastern U. S.)..... **beata**
Mesopleura and pteropleura with a broad black stripe along the lower margin; front shining black up to the anterior edge (Peru, Costa Rica).... **albovaria**

Asteia multipunctata Sabrosky

Two additional localities may be recorded: Manila, Utah, July 17, 1940 (F. Harmston, G. F. Knowlton); and Central, Utah, May 11, 1939 (Knowlton) (Utah Agr. Exper. Sta. Colln.).

Asteia albovaria Aldrich

The species was described from a single male from Peru, and has not since been recorded, to the writer's knowledge. The only other described Neotropical species of *Asteia* is *A. striatifrons* Malloch, which was also described from one male from Peru, and which is distinguished chiefly by the characters noted in the key.

One female, San Jose, Costa Rica, July (H. Schmidt) (U. S. Nat. Mus.), agrees almost exactly with the description of ***albovaria***, notably in such features as the distinctive four-banded appearance of the face. The specimen should perhaps be labeled lectoallotype, but the writer is reluctant to give it such official status on the sole basis of a single specimen from a region quite far removed from the type locality, however probable it may be. The following notes on the thorax of the present specimen are in part an addition to those given by Aldrich, who was unable to ascertain certain features on the holotype.

Female.—Mesonotum shining black up to the lower rim of the notopleura and including the humeri. Pleura whitish-yellow, a black stripe extending along the lower margins of the mesopleura and pteropleura, a large subtriangular black spot on the sternopleura and a small dull spot on the hypopleura. Bristles black and strongly developed: 2 pairs of long dorsocentrals (nearly equalling the apical scutellars in length), 1+1 notopleurals, and 1 postalar. In addition to the long, widely separated, erect, apical scutellar bristles, mentioned by Aldrich, there is one pair of weak, pale subapical bristles, scarcely distinguishable on the yellow scutellum, and little longer than the clothing hairs on the mesonotum. One long sternopleural bristle evident, but it is yellow and not prominent. Metanotum shining pitch black. Halteres with yellow stalk and knob with at least a large black spot on the outer surface, or perhaps even more extensively infuscated. Length of body, 1.75 mm.; of wing, 2.25 mm.

Loewimyia, new genus

Genotype: *Loewimyia bifurcata* Sabrosky, new species.

Generic diagnosis.—Genus near *Asteia* Meigen, lacking the hind cross-vein and the alula. Chaetotaxy: long inner and outer verticals, postverticals present but minute, one pair of weakly developed upper fronto-orbitals, scarcely longer than the other hairs; one pair of very long dorsocentral bristles, equal in length to the long erect apical scutellars; two long sternopleurals. Head large, broader than the thorax, the cheeks linear, oral opening small, face narrowed below, eyes separated at the level of the clypeus by half the width of the front at the vertex. Antennae densely clothed with long hairs, the third segment peculiarly bifurcate and with an irregularly serrate margin (fig. 2).

Wing (fig. 1) similar to *Asteia* but for the common junction of the first and second longitudinal veins in costa, and the strong divergence of the fifth vein from the fourth, beginning proximad the anterior crossvein. Abdominal tergites apparently complete, the segmentation distinct.

No evidence of an arista could be found, though all antennae appeared to be intact on the two specimens available. What at first sight seemed to be a short arista proved to be a long, proclinate bristle on the second antennal segment. If further specimens should prove that this form actually lacks an arista, that would be a particularly important generic character.

Loewimyia bifurcata, new species

Figures 1 and 2

Minute dark-bodied species whose most striking characteristics are the bifurcate antennae and the banded legs.

Head large, wider than the thorax, brown to blackish, only the small face, cheeks, palpi and proboscis yellow. Because of the slightly collapsed head, it is dangerous to state proportion too definitely, but the occiput appears to be strongly concave and the front short. Eyes very large, in profile occupying the entire head, approaching each other so as to narrow the face below, and therefore somewhat emarginate along their anterior margin to allow for the insertion of the antennae. Cephalic bristles and hairs black, only the verticals outstanding. Antennae large, porrect, entirely brown black, densely clothed with unusually long hairs, the third segment deeply notched on its anterior surface, the margin irregularly serrate.

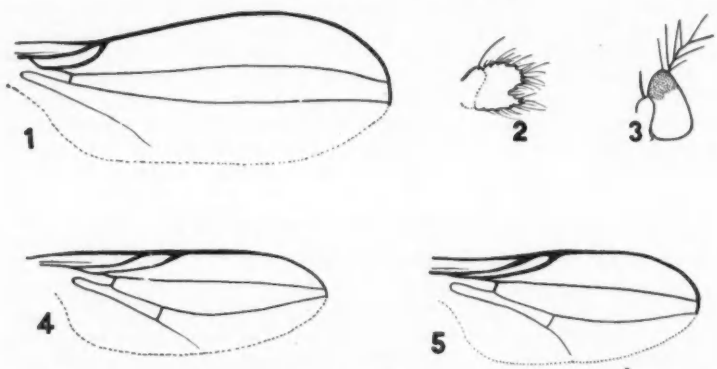


Figure 1, *Loewimyia bifurcata* Sabrosky, wing. 2, *L. bifurcata*, antenna. 3, *Asteimyia antennata* Sabrosky, antenna. 4, *Phlebosotera setipalpis* Sabrosky, wing. 5, *Astiosoma hirta* (Aldrich), wing.

Thorax and abdomen entirely dark brownish black, the margins of the pleural sclerites paler, the whole covered with fine dark pollen. Bristles black, very long and conspicuous on such a tiny insect.

Wing broader than in most Asteiidae in proportion to its length, the submarginal cell very broad, one and one-half times the greatest width of the first posterior cell, the latter narrower than in most species because the third and fourth veins are not so strongly diverging. Fifth vein strongly divergent from the fourth clear back to the base, whereas in *Asteia* and *Asteimyia* the fourth and fifth veins are parallel for some distance beyond the anterior cross vein. Halteres black, the stalk paler basally.

Legs short and weak, bright yellow, with conspicuous black bands at the base and towards the apex of the mid and hind femora, and narrow bands towards the base of the tibiae opposite the apical

femoral bands. The fore legs have a suggestion of the same pattern, but their condition in both specimens is too poor to state it positively. Length of body, .6 mm.; of wing, .8 mm.

Holotype and one paratype, Sabanas, Panama, April 20, 1923 (R. C. Shannon). Sex indeterminable. Types deposited in U. S. National Museum.

Asteimyia new genus

Genotype: *Asteimyia spinosa* Sabrosky, new species.

Generic diagnosis.—Genus near *Asteia* Meigen, lacking the hind crossvein and the alula. Chaetotaxy: long head bristles, 1 inner and 1 outer vertical, and one erect, recurved fronto-orbital, the latter far forward on the front, midway between the median ocellus and the base of the antennae; vibrissae long and porrect; postvertical and ocellar bristles either minute or absent, not discernible in any specimens; 3 pairs of dorsocentrals (one anterior to the mesonotal suture), 1+1 notopleurals, and the anterior intra-alar bristle distinctly developed, about half the length of the dorsocentrals; 1 sternopleural. Head somewhat elongate, the long axis of the eye nearly horizontal, face much broader than its height. Scutellum like *Asteia*, with very long, erect, apical scutellar bristles. Wing similar to *Asteia*, but the first and second veins ending together in the costa. Abdomen largely membranous, judging from the collapsed appearance.

The presence of a strong fronto-orbital bristle so far forward on the front is quite unusual in the family, and the possession of three pairs of dorsocentral bristles has hitherto been known only in *Asteia sexsetosa* Duda from Formosa.

KEY TO THE SPECIES OF ASTEIMYIA

1. Bristles of the head and thorax black and conspicuous; third antennal segment rounded, as long as broad; two black crossbands below the antennae, **spinosa**

   Bristles of the head and thorax bright yellow and hence not as conspicuous; third antennal segment pear-shaped or subreniform; only one black crossband below the antennae..... **antennata**

Asteimyia spinosa new species

Male.—Front yellow to brown, the orbits paler, the central portion and the eyes sunken so that their proportion cannot be determined. Occiput concave, brown. Face and cheeks bright, whitish yellow, the former strikingly marked with two black-brown, parallel crossbands, the one between the widely separated vibrissae across the anterior oral margin, and the other connecting the eyes midway between the oral margin and the base of the antennae. Proboscis and palpi pale yellow. Antennae orange, the third segment brown above, arista black with several long rays toward the base; second antennal segment with a long, erect, diverging black bristle, adding further to the spinose appearance. Cephalic bristles black and strong, the fronto-orbitals as long or longer than the outer verticals, and nearly as long as the conspicuous dorsocentrals.

Thorax entirely bright whitish-yellow below the notopleural ridge, and brown above, including the humeri and metanotum, the two areas sharply demarcated. The brown mesonotum is marked with paler yellowish-brown areas which divide it into six brown stripes, of which the median pair extend back over the sides of the scutellum, the whole finely pollinose and slightly dull. Bristles long, black and conspicuous.

Abdomen collapsed, probably chiefly membranous, the apex sclerotized and bright yellow, as are the claspers. Wings clear, veins brown, apex of second vein enlarged, submarginal cell very broad, slightly wider than the greatest width of the first posterior cell; the fifth vein fades out far before the margin of the wing. Halteres with yellow stalk and black knob. Legs weak, entirely pale yellow. Length of body, .9 mm.; of wing, 1.25 mm.

Holotype, male, Higuito, San Mateo, Costa Rica (Pablo Schild). Paratypes, six specimens with same data, topotypic (1 ♂, others in poor condition). Type series in the U. S. National Museum.

Asteimyia antennata, new species

Figure 3

Close to *A. spinosa*, but the body color paler, bristles bright yellow instead of black, and the antennae peculiarly developed.

Male.—Head yellow, only the ocellar spot, the upper fourth of the third antennal segment, the arista, and a band across the face between the bases of the vibrissae, black. Cheeks narrower than in *A. spinosa* and the cephalic bristles are shorter. Antennae porrect, much higher than long, and since the unusual height appears due chiefly to extension on the dorsal side, the antennae project above the front in profile. Third antennal segment sub-reniform to pear-shaped, the anterior margin nearly straight and the lower half larger than the dorsal portion (fig. 3). Arista with six or seven long rays.

Thorax as in *A. spinosa*, sharply demarcated into an upper brownish and a lower whitish yellow portion by a dark brown band along the notopleural ridge, the whole covered with a sparse pale pollen. The disk of the mesonotum paler, though in dark specimens with a suggestion of a pair of median stripes which end approximately opposite the middle pair of dorsocentral bristles, and on each side a longer lateral stripe which extends from the mesal angle of the humerus to the posterior dorsocentral bristle, the posterior slope of the mesonotum and the scutellum entirely yellow. Metanotum yellow above, shining brown below. Bristles long and bright yellow, the notopleurals darker.

Abdomen collapsed, apparently membranous, the apex shining yellow and sclerotized. Wing near *A. spinosa*, the submarginal cell not quite as broad and the apex of the second vein not enlarged. Halteres brown. Legs weak, pale yellow. Length of body, 1.25 mm.; of wing, 1.75 mm.

Holotype, male, Higuito, San Mateo, Costa Rica (Pablo Schild). Paratypes, five specimens, same data, topotypic (apparently 2 ♂, 1 ♀, and 2 ?). Type series in the U. S. National Museum.

Genus **Crepidohamma** Enderlein

(=*Sigaloëssa* Loew, 1865, nec Blackwall, 1864.)

The group of species listed under *Crepidohamma* have long been known under the name of *Sigaloëssa*. In the course of preparing the check list, the writer was astonished to find in Neave's Nomenclator Zoologicus a reference to an earlier use of the name *Sigaloëssa*, cited as "*Sigaloëssa* (Templeton MS) Blackwall 1864, Hist. Spiders, 2, 198.—Arachn." The name was not listed in the Zoological Record for 1864, and apparently has long been overlooked.

Blackwall (1864, History of the Spiders of Great Britain and Ireland, vol. 2, p. 198, and plate 14) described and figured a new species ***Theridion auratum***, under which he cited in synonymy "***Sigaloëssa auratum*** Templeton MS. History of Irish Arachnida." Blackwall accepted the species as new, using Templeton's suggested name, but he did not accept the latter's proposed genus.

Under Opinion 4, the manuscript names acquired standing in nomenclature when they were published by Blackwall and must be credited to him. The situation is practically identical with that discussed in Opinion 24 of the International Rules, ***re Antennarius*** Commerson MS, published but not accepted by Lacépède, who mentioned the name in synonymy. It must be concluded therefore that *Sigaloëssa* has nomenclatorial status as of Blackwall 1864, who published it in connection with a duly described species, even though he did not accept it as a genus. It has been recorded in the literature as a synonym of ***Theridion*** by Petrunkevitch, in the Systema Aranearum (1928, Trans. Conn. Acad., XXIX, p. 246).

Sigaloëssa Loew (1865) must therefore be regarded as a homonym. Since *Crepidohamma* Enderlein (1915) is here found to refer to the same group, that name is hereby adopted as the next available name, making it unnecessary to propose a new name.

The status of *Crepidohamma* Enderlein may be questioned by some because of its separate recognition by recent authors (Duda, Curran), though Sturtevant (1921, Carnegie Inst. Publ. No. 301, p. 106) had stated it to be a synonym of *Sigaloëssa* Loew. Curran (1934, Fam. Gen. N. Amer. Diptera, p. 328) in his key distinguished *Crepidohamma* by "Front with two bristles near the middle, half way between the ocellar triangle and antennae" whereas *Sigaloëssa* Loew was said to have "Front with only weak bristles laterally." The latter apparently is true for *S. rica* Curran, but *S. bicolor* Loew, the genotype, has a rather long, strong, fronto-orbital bristle about midway on the front, slightly anterior to the level of the median ocellus. Duda (1927, Deut. Ent. Ztschr., p. 119) did not include *Sigaloëssa* in his key, but characterized *Crepidohamma* in part as follows: "Stirn teilweise matt, nahe der Medianlinie auf der Stirnmitte mit zwei Borsten, danach Oz. anscheinend weit vorn stehend." Duda stated definitely that the species was unknown to him, and his version could only have been based on the published description.

Enderlein's original description of *Crepidohamma brasiliense* reads: "An dem Augenrand je 1 Borste in der Mitte der Stirn, und 2 nahe der Medianlinie in der Mitte der Stirn. An der Seite des Scheitels eine

lange Borste." Duda recognized that the bristles near the mid-line of the front must appear like the ocellars (which are normally proclinate and may superficially appear to arise farther forward than is actually the case). Indeed, Enderlein does not mention the ocellars, nor does he indicate how well developed either these or the orbitals are. If we interpret his description, which is somewhat indefinite on these points, as meaning that the front showed one distinct pair of fronto-orbital bristles and one pair of proclinate ocellars, the entire characterization will match that of *Sigaloëssa* Loew. It is of course possible that *Crepidohamma* is really distinct on this or other characters, but until it can be proved, I prefer to regard them as one and the same and to avoid the creation of a new name for *Sigaloëssa* until the premises for such action are properly established. Fortunately, Enderlein's excellent figure of the wing of *Crepidohamma* and his further notes on the venation leave no doubt of its separation from *Astiosoma* and *Phlebosotera*.

It may be noted that most of the species heretofore described as *Sigaloëssa* may be referred to *Astiosoma* Duda. Of those not found in our check list, it appears from the description that *S. insularis* Malloch (1930), from the Society Islands, falls in *Crepidohamma* as here defined.

KEY TO THE AMERICAN SPECIES OF CREPIDOHAMMA END.

1. Thorax pale ferruginous to reddish yellow (Puerto Rico) ..... **rica**
   Mesonotum black 2
2. Posterior half of the front black (So. Brasil) ..... **brasiliense**
   Posterior three-fourths of the front black 3
3. Legs entirely yellow or with a small oval black spot on the outer surface near the apex of the fore femora (West Indies and Central America) .. **bicolor**
   Legs yellow with conspicuous, black to black-brown bands 4
4. Thorax entirely brown to pitch black; fore coxae dark brown; tibiae entirely yellow (Panama) ..... **cinctipes**
   Humeri and part of the pleura bright yellow; fore coxae yellow; fore and middle tibiae with narrow black basal bands (Costa Rica) .... **pseudocinctipes**

Crepidohamma bicolor (Loew), n. comb.

(=*Sigaloëssa frontalis* Aldrich, 1915, Psyche, XXII, p. 98. New synonym.)

Male, Soledad near Cienfuegos, Cuba, Aug. 6–20 (N. Banks), and male, five females, Soledad, Cuba, Feb. 25, 1925 (George Salt) (Mus. Compar. Zool., Harvard); five males, one female, Higuito, San Mateo, Costa Rica (Pablo Schild); male, two females, San Jose, Costa Rica, "V : 15 : VII" (H. Schmidt); female, Sabanas, Panama, April 20, 1923 (R. C. Shannon); male, Monte Liro, Canal Zone, Aug. 28, 1923 (R. C. Shannon); female (?), Ancon, Canal Zone, Oct. 8, 1923 ("Ex pods of *Moringa oleifera*"); one, Corazal, Canal Zone, March 1, 1912 (August Busck); one, Trinidad Rio, Panama, March 16, 1912 (August Busck). (U. S. National Museum.).

Loew described the species from the female sex as having entirely yellow legs. The small series from Cuba indicated that the males had an oval dark brown to black spot on the distal fourth of the posterior surface of the fore femora, but the distinction did not seem to hold true in the series from Central America. Perhaps this was due to the condition of the specimens, since the abdomens are so collapsed that one cannot always be sure of the sex, or perhaps another almost identical form is

intermingled. At any rate, the latter series cannot be distinguished from what is regarded as typical *bicolor* from Cuba.

Two aberrations in chaetotaxy were noted, both of which suggest that those characters be used with caution unless supported by other evidence. The specimen from Sabanas, Panama, possessed two well-developed fronto-orbital bristles on the left side and only one on the right. In the Ancon example, there were two bristles inserted very close together at the position of the left anterior dorsocentral, but only the normal single anterior dorsocentral on the right, resulting in the appearance of a row of three bristles on the left side and two on the right.

Crepidohamma cinctipes, new species

A shining black species, marked with yellow.

Female.—Head black to black-brown, including the narrow, shining black horseshoe-shaped oral margin, which is strikingly distinct beside the silvery white cheeks and yellow face; a narrow anterior frontal margin and the antennae deep yellow to orange, the latter browned dorsally. Clypeus and palpi brown, the proboscis yellow. Front subquadrate, the one pair of moderately developed fronto-orbital bristles slightly anterior to a line drawn through the median ocellus. Ocellars and postverticals short and inconspicuous. Cheeks narrow. Antennae pendant, the third segment ovate, arista long, moderately zig-zag with a number of short rays, apparently about eight on each side.

Thorax shining pitch black, though covered with a sparse, fine pollen which scarcely interrupts the shine, only the scutellum bright yellow, the humeri, notopleura, and margins of some of the pleural sclerites pale brown. The two pairs of dorsocentral bristles and two sternopleurals long and dark brown, the long apical scutellars pale brown.

Abdomen chiefly membranous, the sclerotized tergal areas confined to a short plate at the base adjacent to the metanotum and a complete band around the apex, between which is a row on the median line of three short, narrow tergites, whose width is little more than the space separating the apical scutellar bristles; sclerotized areas dark brown.

Wings essentially like the figure of the wing of *Sigaloëssa rica* in Curran (1934, op. cit., p. 328, fig. 1), the discal cell a little longer and narrower, and the third and fourth veins not as close together at their apices. Halteres with black knob and yellow stalk.

Legs bright yellow, the fore coxae, apical three-fifths of the fore femora, and broad bands near the apices of the mid and hind femora, black to pitch black.

Length of body, 1.4 mm.; of wing, 1.75 mm.

Holotype, female, Cano Saddle, Gatun Lake, Panama, May, 1923 (R. C. Shannon). Type in the U. S. National Museum.

The specimen is brightly colored and in excellent condition, and appears as if mounted out of alcohol or other preservative. The abdomen is thus well preserved and fully distended. From it one can understand why in specimens of certain genera (e. g., *Crepidohamma* and *Asteimyia*) the abdomen is so often a dark shapeless mass, because of the predom-

inantly membranous condition. Other genera observed (*Loewimyia*, *Astiosoma* spp.) have the tergites complete. This character may well be of generic importance, but because of the frequently poor condition of the specimens one cannot always apply it with certainty.

Crepidohamma pseudocinctipes new species

Similar to *C. cinctipes*, differing slightly in coloration of legs and pleura.

Female.—Front considerably longer than broad. Arista long, with about ten short rays on each side. Humeri, upper posterior third of the mesopleura, the upper part of the pteropleura, and at least the upper part of the sternopleura, bright yellow. Fore coxae bright yellow, in some specimens with a brown streak; the apical black bands on all femora narrower than in *C. cinctipes* and apparently the fore and hind tibiae typically with narrow black bands towards the base, directly opposite the femoral bands. Length of body, 1.25 mm.; of wing, 1.5 mm. Otherwise as described for *C. cinctipes*.

Holotype, female, Higuito, San Mateo, Costa Rica (Pablo Schild). Paratypes, seven specimens (1 ♂, 1 ♀, 5 ?), same data. Type series in the U. S. National Museum.

The two new species of *Crepidohamma* described above are very similar, and the writer was at first inclined to group them all as one species. However, the complete absence of bands of infuscation on the tibiae of the well preserved Panama specimen, and their presence on the Costa Rican material in comparatively poor condition, leads one to suspect that the character may be a characteristic difference in the two populations. Slight differences in other features also suggest the expediency of recognizing the two forms at this time, though further material might indicate that they were only subspecies or perhaps varieties of the same species. In some specimens of *pseudocinctipes*, the tibial bands are very faint, but this is apparently due to their poor condition.

Genus **Phlebosotera** Duda

Phlebosotera is here recorded from North America for the first time. Duda's proposal of this and the following genus (*Astiosoma*) was adopted only after a careful analysis of the characters of the several genotypic species and their relatives, including the American species described under *Sigaloëssa* Loew (cf. *Crepidohamma*).

It appears to the writer that Duda's genera may be maintained as separate entities with the characters indicated in the key. Three species referable to *Phlebosotera* are available—from Utah, Southwest Africa, and Palestine—and all agree closely in all structural characters, and indeed can only with great difficulty be separated from one another specifically. *Astiosoma* is closer to *Sigaloëssa* Loew than is *Phlebosotera*, and the latter has much more claim to recognition.

Another character which may be significant in establishing *Phlebosotera* as a valid genus is the presence of distinct folds or ridges marking the position of the sixth longitudinal vein and a truncate anal cell. One might infer from Duda's (1927) key that the veins bounding the anal

cell are actually present, but as Hendel has already noted (Bull. Soc. Roy. Ent. Egypte, 1931, p. 65), they are not definite veins but merely folds. For that reason Hendel doubted their importance as generic criteria. However, this appearance (as figured by Duda, 1927, pl. 5, fig. 5) is present in all three species of *Phlebosotera* now before me, whereas in all species of *Sigaloëssa* and *Astiosoma* known to me the sixth vein is not developed and the anal cell is not truncate and is only weakly indicated as a narrow oval area at the base of the discal cell (cf. Duda, 1927, pl. 5, fig. 6, wing of *Astiosoma rufifrons*).

Phlebosotera setipalpis, new species

Figure 4

Bright yellow species with reddish mesonotum, darkened so as to appear striped; palpi with long porrect terminal bristles.

Male.—Head entirely yellow, only the arista and a spot between the ocelli black; the face, cheeks and clypeus nearly white; the front, occiput centrally, and antennae deep yellow, the genovertical plates slightly darker. Front barely wider than an eye, the sides slightly convergent anteriorly. Occiput concave. Eyes bare. Cheeks narrower than the breadth of the third antennal segment, and approximately one-fifth the vertical height of an eye, with a row of 5–6 pale whitish yellow hairs on the lower margin and a pale but distinct vibrissal hair. Third antennal segment ovate, arista slender and apparently bare, but with minute pubescence under high magnification. Palpi long and slender, each bearing a pale yellow terminal bristle fully as long as the palp itself and in the specimen at hand these bristles are porrect, outwardly curved, and cruciate, appearing from above as diverging bristles projecting from the oral margin. Frontal bristles and hairs yellow to brown; the inner and outer vertical bristles well developed; ocellars minute, proclinate and widely divergent; postverticals indistinguishable from a group of minute postocellar hairs; fronto-orbitals minute, with one pair opposite the median ocellus a trifle longer and darker than the others; frontal hairs generally sparse, but numerous just above the antennae.

Thorax and scutellum with whitish yellow ground color, the mesonotum up to the notopleura and humeri deep yellow to reddish, laterally pitch brown to black and appearing as a stripe on each side extending from the neck mesad of the humerus and back to the postalar bristle as a narrow supra-alar vittula. Between these infuscated margins, the mesonotum is slightly darkened as four vittae, the two outer (whose lateral margins are also infuscated) ending at the dorsocentral bristles, and the mesal two somewhat abbreviated. Entire thorax subshining, but thinly bright yellow pollinose. Pleura with brown to reddish brown spots as follows: two small spots beneath each humerus, an elongate oval spot along the lower margin of the mesopleura, a large subtriangular spot on the sternopleura (chiefly reddish, but infuscated on the upper third), and a spot on the hypopleura. Metanotum large and black, subshining but chiefly covered with sparse pale pollen. Bristles long, yellow to brown: 1 anterior notopleural (posterior broken?), 1 postalar, 1 posterior dorsocentral,

1 apical and 1 subapical scutellar, and 1 sternopleural. Mesonotal hairs short and pale, arranged in eight regular rows, with two rows of acrostichals. Mesopleura hairy.

Abdomen in poor condition, but seems predominantly yellow; male genitalia large and knob-like, deep yellow, shining, thickly beset with short, erect hairs. Wings (fig. 4) hyaline, veins yellow, the venation identical with that figured by Duda (1927, pl. 5, fig. 5) for the genotype, *P. mollis*. Halteres yellow. Legs slender, entirely yellow, only the claws black. Length, 2 mm.

Holotype, male, Delta, Utah, July 5, 1938 (G. S. Stains). To be returned to the Utah Agricultural Experiment Station Collection, for ultimate deposit in the U. S. National Museum.

It is possible that the unusually long bristles on the palpi are characteristic only of the male sex, as noted for certain *Hippelates* (Chloropidae). However, they are not found in an available male of the genotype, *Phlebosotera mollis* Duda, and may be regarded as a specific character.

Genus **Astiosoma** Duda

Acceptance of this generic concept involved relocation of the species originally described under *Sigaloëssa* Loew. As shown by the check list, the Neotropical species are retained in the latter group (under the name *Crepidohamma* to replace *Sigaloëssa* Loew, preoccupied); the Nearctic species are referred to *Astiosoma*. Malloch (1930, Ann. Mag. Nat. Hist., ser. 10, VI, pp. 321, 322) had already noted that *Sigaloëssa flaveola* Coquillett belonged there, as well as his *S. melbournensis* from Australia.

The key to "*Sigaloëssa*" given by Aldrich (1915, op. cit., p. 96) covers the species referred to *Astiosoma*, along with *bicolor* Loew. However, it cannot be used for the species because through some error, *hirta* Aldrich is keyed as having "mesopleura without stripe" whereas the description definitely states that the mesopleura does have a stripe on the lower part.

KEY TO THE AMERICAN SPECIES OF ASTIOSOMA DUDA

1. Mesonotum reddish-yellow (eastern U. S.) ..... **flaveola**
   Mesonotum shining black 2
2. Mesopleura with a black stripe just below the notopleural suture (Idaho), **lineata**
   Mesopleura with a black stripe along the lower margin, adjacent to the sternopleura (Idaho; N. C.?) ..... **hirta**

Astiosoma flaveola (Coq.)

The only locality I can add to published records is Falls Church, Va., October 7 (N. Banks) (Mus. Compar. Zool.).

Astiosoma hirta (Ald.), n. comb.

Figure 5

Described from a single female, Potlatch, Idaho. In material received from the U. S. National Museum are four females, Yale, Latah Co., Idaho, July 28, 1927 (J. M. Aldrich). Cf. fig. 5, wing.

Astiosoma sp. (**hirta** Ald.?)

One female, Raleigh, N. C., Aug. 22, 1936 (C. S. Brimley) (N. C. Dept. Agr. Colln.) cannot be separated from *A. hirta* Aldrich. The North Carolina specimen has a row of three hairs on the sternopleura compared with four in available specimens of *hirta*, and the front is a trifle narrower, but these differences seem slight. Because of the widely separated localities, one is inclined to doubt the identity, but lack of sufficient material precludes a definite decision. The specimen is recorded here because it is important to note the presence of another species of *Astiosoma* (besides *flaveola*) in eastern United States. It may also be added that this is the first record of the family from North Carolina (cf. Brimley, 1938, Insects of North Carolina).

CHECK LIST OF THE AMERICAN ASTEIIDAE

Asteia Meigen, 1830, Syst. Beschr., VI, p. 88.
- *albovaria* Aldrich, 1915, Psyche, XXII, p. 95. (Peru.)
- *beata* Aldrich, 1915, Psyche, XXII, p. 95 (Mass.; oc. Maine to Ill.).
- *multipunctata* Sabrosky, 1939, Pan-Pacific Ent., XV, p. 165. (Brit. Col. to N. Mex.).
- *striatifrons* Malloch, 1930, Ann. Mag. Nat. Hist., (ser. 10), VI, p. 323. (Peru).
- *tenuis* Walker, 1858, Trans. Ent. Soc. (London), V, p. 331. (U. S.). Probably not an Asteiid.

Asteimyia Sabrosky, n. gen.
- *antennata* Sabrosky, n. sp.
- *spinosa* Sabrosky, n. sp.

Astiosoma Duda, 1927, Deut. Ent. Ztschr., 1927, p. 119, 127.
- *flaveola* Coquillet, 1898, Jour. N. Y. Ent. Soc., VI, p. 49, (*Sigaloëssa*) (N. H. to Fla.; oc. west to Kansas).
- *hirta* Aldrich, 1915, Psyche, XXII, p. 97 (*Sigaloëssa*). (Idaho). N. comb.
- *lineata* Aldrich, 1915, Psyche, XXII, p. 96. (*Sigaloëssa*). (Idaho). N. comb.

Crepidohamma Enderlein, 1915, Wien. Ent. Ztg., XXXIV, p. 185.
(=*Sigaloëssa* Loew, 1865 (1866?) nec Blackwall 1864).
- *bicolor* Loew, 1865 (1866?) Berl. Ent. Ztschr., IX, p. 186. (*Sigaloëssa*). (Cuba). N. comb.
- *brasiliense* Enderlein, 1915, Wien. Ent. Ztg. XXXIV, p. 186. (Brasil).
- *cinctipes* Sabrosky, n. sp.
- *frontalis* Aldrich, 1915, Psyche, XXII, p. 98. (*Sigaloëssa*). (Peru)= *bicolor* Loew. N. syn.
- *insularis* Curran, 1931, (*Sigaloëssa*). Preoccupied, cf. *rica*. (Puerto Rico).
- *pseudocinctipes* Sabrosky, n. sp.
- *rica* Curran, 1934, Fam. Gen. N. Amer. Dipt., p. 328. (*Sigaloëssa*). N. comb.

(=*Sigaloëssa insularis* Curran, 1931, Amer. Mus. Novitates No. 456, p. 13, nec *S. insularis* Malloch 1930).

Leiomyza Macquart, 1835, Hist. nat. Dipt., II, p. 605. (= *Liomyza* auctt.)

melanderi Aldrich, 1919, Ent. News, XXX, p. 141. (Wash., Ida., Quebec).

slossonae Aldrich, 1919, Ent. News, XXX, p. 140. (Wash., Ida., N. H.).

Liomyza Agassiz, 1846, et auctt. (emend. pro *Leiomyza* Macquart, 1835).

Loewimyia Sabrosky, n. gen.

bifurcata Sabrosky, n. sp.

Phlebosotera Duda, 1927, Deut. Ent. Ztschr., 1927, pp. 119, 125.

setipalpis Sabrosky, n. sp.

Sigaloëssa Loew, 1865 (1866?), Berl. Ent. Ztschr., IX, p. 186.
Preoccupied by *Sigaloëssa* Blackwall, 1864, Hist. Spiders, II, p. 198.
Cf. *Crepidohamma* End.

dispar Schiner, 1868, Novara Reise, p. 237, (*Sigaloëssa*). (S. Amer.). Not an Asteiid, from the description.

Stenomicra Coquillett, 1900, Proc. U. S. Nat. Mus., XXII, p. 262.

angustata Coquillett, 1900, Proc. U. S. Nat. Mus., XXII, p. 262. (Puerto Rico).

THE EARTH AND MAN—A HUMAN GEOGRAPHY, by DARRELL HAUG DAVIS. Pages xiii+675, 7½ x 10¼ inches, 452 figures. Published by THE MACMILLAN COMPANY, New York. 1942. Price, $4.25.

All biologists will agree to the desirability of a broad background of training in a variety of subjects for work in the field of biology. The biologist needs an appreciation of ecology and interrelationships, and above all, he needs a concept of human ecology in its broadest sense in order to see his own limited field in its proper perspective. Geography, which is essentially a phase of human ecology, is a subject too often neglected by students of biology. The present book is an excellent treatment of ecological human geography.

This book is intended as a text for beginning classes in geography, and is written to supply a background of information and to establish certain principles. The treatment is divided into five parts: Part I (pp. 1–14), Introduction, outlines the historical development of geography and mapping; Part II (pp. 15–102), Man and Environment, discusses the distribution of man, interactions between man and environment, and environmental changes resulting from natural and human agencies; Part III (pp. 103–361), Limiting Effects of Environmental Factors, discusses climate, soils, land forms and drainage, minerals, inland waters, oceans, and space, and the limitations each imposes on the potentialities of an area for effective human use; Part IV (pp. 362–594), How Man Obtains His Living, deals with man's economic activities and their environmental basis (primitive hunting and fishing, grazing, agriculture, forestry, mining, transportation, industry, and urbanization); Part V (pp. 595–664), Appendix, includes discussions and illustrations of map projection, topographic mapping, solar relations and the reckoning of time, weather maps and weather prediction, climate and soil classifications, and contains a number of useful tables.

The book shows evidence of careful preparation and editing. The subject matter is well organized and clearly presented, and the illustrations are excellent. The many maps, charts, and photographs have apparently been carefully selected and captioned to supplement the accompanying text, and the reader can follow the subject through the book merely by studying the illustrations. The type is somewhat smaller than that in most texts, and is set in two 2¾-inch columns to the page.

This book is not only interesting reading, but contains much of value to the biologist. We heartily recommend it to anyone who wants to better understand the relationships between man and his environment.—D. J. B.

THE NESTING HABITS OF MEXICAN SOCIAL AND SOLITARY WASPS OF THE FAMILY VESPIDAE

PHIL RAU,
Kirkwood, Missouri

A second trip to Mexico during July 1940 yielded some interesting data on the nesting habits of certain social and solitary Hymenoptera of the family Vespidae.[1]

Entering Mexico from McAllen, Texas, our route ran from Reynosa across the desert to Monterey and thence via the International Highway to Mexico City, and down from the central plateau to Acapulco on the Pacific, then back to Mexico City and out on the southeast spur to Orizaba and Cordoba, and by the northeast spur through Jalapa to the city of Vera Cruz on the Gulf of Mexico. The routes to Vera Cruz and Acapulco were not covered in the 1939 trip (see Ann. Ent. Soc. Amer. 33: 81, 1940). Collections and observations were made along the highway, and three short side trips were taken: one to Coatepec, eight miles from Jalapa (alt. 4500 ft.), one to Pie de la Cuesta (alt. 6 ft.) near Acapulco, and one to Xilitla (alt. 2000 ft.) near Tamazunchale.

Locality records are easily made all along the highways of Mexico because each kilometer is marked designating the distance from the national capital. One needs only to record the nearest kilometer number and later consult his map for the exact geographical location. Abandoned buildings, the favorite nesting site of many wasps, are few along the highway, since practically everything is utilized by the natives as a habitation. One must therefore resort to scanning the vegetation and the underside of bridges and culverts on the road for likely material. The bridges and culverts under the older roads in the tropical regions of low altitude are often rich in insect life; those recently constructed are only beginning to acquire their insect fauna. In this respect I noticed that there was a marked difference in the fruitfulness of certain new culverts in the two trips, only sixteen months apart.

These culverts and bridges were soon found to be a fair index of the region's entomological resources. For example, along the old road in the arid region from Reynosa to Monterey for a distance of 140 miles, a hundred culverts were searched in vain. In contrast to this dearth of life in the high desert region the insect fauna became abundant in culverts as soon as we entered low tropical regions. It is of course conceded that culverts, bridges, and roadsides do not tell the story of the insect fanua in the hinterland, yet in general it is an indicator which helps the naturalist to decide whether or not to penetrate further into the wilderness.

The heavy task of identifying all of the Vespidae discussed here was generously undertaken by Dr. Joseph Bequaert, to whom I wish to

[1]Other papers in course of preparation from data collected on this trip are on certain solitary wasps (Sphecidae), on social and solitary bees, and on the behavior of certain butterflies.

express my very deep appreciation. I also wish to express my thanks to the entomologists who identified insects other than wasps, and whose names appear in brackets after the species name.

POLYBIA WASPS

Metapolybia cingulata Fabr.

The nest of this wasp is a single comb which is attached to a horizontal support or beam. It is unique in that the wasps cover this comb with a layer of brown paper beautifully studded with transparent windows. This covering is rather loosely spread beneath the comb, leaving an air space as well as walking room for the colony of adults. The sheet of papery covering looks very much like the bark of trees, and for another nearly related species, *M. pediculata* in Panama, Dr. Bequaert states that they "usually build nests against trees, the outer envelope then imitating perfectly the bark, and is often speckled with algae, lichens, etc." (Jungle Bees and Wasps of Barro Colorado Island, p. 52, 1933). The covering of *M. cingulata* also resembles bark, and I often wonder how many of these nests I failed to see in the woods because of this close resemblance.

Only two nests of this species were seen; one at Tierra Colorado on the road to Acapulco, and one at Cordoba. The colonies and nests do not go on forever, and the one at Tierra Colorado was in the first stages of disintegration; all cells were empty of eggs or larvae but six cells were sealed with pupae; the paper covering of the comb was badly tattered, and the three old adults on the nest were easily taken.

It was with some satisfaction that I took the nest at Cordoba, for I had seen it the year before but had no way to reach it. The memory of it had been tantalizing me for sixteen months, so it was with a feeling of triumph that I harvested the nest with the aid of a small step-ladder brought all the way from Kirkwood explicitly for that purpose. The colony was active in July 1940, as it had been also in February 1939; this indicates that establishments of this kind are more or less perennial in this climate, although the nest had not increased very much in size during the sixteen months. The cells were firmly attached to the under side of a horizontal stone beam. The comb was irregularly round in shape, made of light-weight chocolate-brown paper which had the appearance and texture of rough, crumbly cardboard, in contrast to the firm, closely-knit cardboard of *Mischocyttarus immarginatus*.

There were about fifty adults in the nest. The comb contained 315 cells; of these 160 were sealed with pupae, and 155 contained eggs or larvae or were entirely empty. The cells were narrow (eight to the inch) and were three-eighths of an inch in depth. The larvae had spun grayish-white silken caps over the cells before pupating, but the caps had not remained white for long for the workers had the strange habit of glueing tiny bits of brown paper pulp over them. They did not cover up the caps completely but scattered these adhesive crumbs here and there. The gray-white base flecked with these dark-brown crumbs gave the appearance of weathered lichens. This condition was seen in the Tierra Colorado nest also. I cannot see any utilitarian purpose for this

reinforcement or camouflage, inasmuch as these cells are not exposed to view but are covered by the curtain of paper with windows. Also, after the larvae capped the cells the workers built a ring of paper around each cap as though they were extending the cells. These rings were only 1/64 to 1/32 inch high, and would probably not have been noticed at all without the aid of a lens. It was plain that they had been placed there after the larvae had done their spinning.

Another ingenious trick, artistic or utilitarian, of *M. cingulata* is the placing of windows in the brown paper covering over the comb. The paper is not smooth, but quite crinkled and bubbly, and contains small glistening spots that look like mica. This same clever habit was observed for *Metrapolybia pediculata* in Panama (Jungle Bees and Wasps of B. C. Is., pp. 46–56, 1933), and Howes (Nat. Hist. 33: 100, 1933) describes the paper nest of a *Polybia* wasp from the tropics (specific name and locality not given) "with its surface studded with tiny sheets of an almost transparent substance that admits light into the nest galleries, and reminded me of a factory with its well lighted interior."

In the nest of *M. pediculata* mentioned above, the "panes of glass" covered approximately one third of the surface, while in the nest of *M. cingulata* more than half of the area was translucent, and when held to a lamp the light streamed through these little windows. In fact, the windows were so numerous in parts of the cover that it looked very much like a beautiful piece of lace. In the present nest they did not occur in the sheet promiscuously, but in some places were thickly set in rows, and since many of these panes were built in as a sheet of glass is puttied in, it is quite unlikely that these transparent spots are due to some clear vegetable sap accidently getting mixed with the wood pulp. If this material was accidently mixed with the pulp we would find windows in the walls of the brood cells as well.

Polybia occidentalis Olivier

Figures 1, 2, and 21

This wasp has attracted the attention of many observers because of its large and conspicuous bell-shaped or cylindrical paper nests. In a valuable paper, Dr. Herbert F. Schwarz, (Am. Mus. Novitates No. 471, 1931) records the nesting behavior of *P. occidentalis* var. *scutellaris* which he studied in Panama, and reviews also much of the literature on this species. I have recorded its nesting behavior in Panama (*l. c.*, 56–65, 1933), and in a recent paper (Ann. Ent. Soc. Amer., 33: 81–85, 1940) I gave some details of its habits during the month of February in Mexico, where I saw several colonies in the early stages of nest founding, as well as a large colony two years old that was spending the dry season resting within the nest. In spite of all that has been written on this species, one cannot observe a colony or its nest for long, without discovering something new in the lives of these creatures.

The localities where these nests were taken were Cuernevaca and Taxco in Morelos; Acapulco, Pie de la Cuesta, Iguala and Mexcala in Guerrero; Jalapa and Vera Cruz, V. C., and at Jacala, Hidalgo. During the month of July, I saw about twenty nests, and collected ten of them for study. At that time I found them in all stages of colony formation.

Unlike other species of social wasps in Mexico, *P. occidentalis* does not have clearly defined seasons for any one of its activities; new nests and swarming, as well as heavily colonized nests, may occur at any one time.

In July I found colonies in every stage of development from the swarming stage before the new nest had even been begun, through small nests with only one comb, to nests 8 to 12 inches in length and containing as many as eight or more combs, and finally to the decline and ultimate abandonment of a huge nest by a colony that had been building it for three and one half years.

The nests were attached to man-made structures such as native huts, tourist cabins, under bridges and in culverts. and under the protection of overhanging rocks in bluffs. Some small nests were even built on the under surface of the broad banana leaves. Some were attached to trees and to woody vegetation where they were fully exposed to view, often hanging in such a way as to look like an oriole's nest. One nest high on a liana overhanging the mountain road at Xilitla actually had an orchid growing from its roof. There was much variation in the color of the nests, all the way from a light cream-yellow to a dark chocolate-brown, and sometimes a nest was mottled with various shades of tans, grays and browns; this, of course, indicated that the wood pulp was gathered from various sources.

The very earliest stage in which a colony was discovered was a swarm at Pie de la Cuesta, spending the night there before going out to begin their new home. This emigrating swarm was seen at dusk, a double handful of wasps clinging close onto one another on a horizontal branch five feet from the ground. I faced a difficult decision; should I take the swarm in order to determine if it was composed of males, females or workers, or should I risk losing them in the hope of seeing them build a new nest? The latter desire prevailed—but next morning, alas! the swarm was gone, and a thorough search of the surrounding vegetation showed no evidence of nest or swarm. Hence it seems that they were merely spending the night on the branch, and had not collected to found the new nest there.

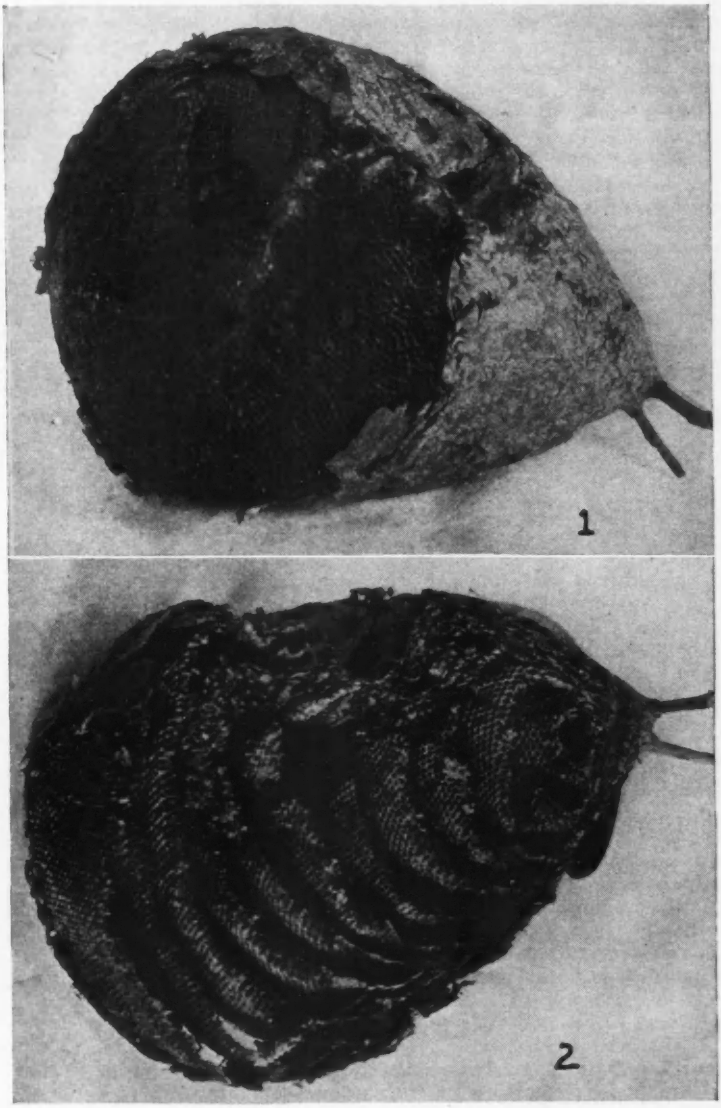
The other extreme, the decline of a colony and the final abandonment of a nest three and one half years old, was watched at Tamazunchale, where it was under the roof above the pump at a gasoline station (Ann. Ent. Soc. Amer. 33: 81–84, 1940). The nest when I first saw it was two years old; it was bell-shaped and measured 10 inches in vertical length and the oval bottom (floor of the bell) measured 6x7 inches in diameter. This nest showed a rapid increase in size during the year and a half between my visits. The length had increased 3 inches, and now was 13 inches, while the last comb on the bottom of the nest measured 7x9 inches. Considering the fact that these additions were all on the largest parts of the nest, the growth has been more rapid than the average rate of growth during the previous time.

When we visited the nest early in July 1940 only a few wasps were on

---

EXPLANATION OF PLATE I

Figures 1 and 2. Exterior and interior of nest of *Polybia occidentalis* (⅓ nat. size).


1
2

the outside of the nest and a few guarding the doorway, and I learned from the proprietor that the colony had been weak and inactive for two months and nest enlargement had ceased. When I returned again three weeks later no wasps were to be seen, and probing into the nest with a wire failed to arouse any response. I wanted to hold a post-mortem on the nest to learn the probable cause of the decline of the colony, but it was held in such high esteem as a beautiful and novel ornament to the station that I was not permitted to remove it.

We are in the habit of thinking of these colonies and their nests as perennial, but we find old, abandoned nests which indicate that while they may be perennial they certainly are not everlasting. One such empty nest was swinging in the breeze in a leafless tree at Iguala in February 1939. This was a large and well constructed one (figs. 1 and 2), measuring 10 inches in length and 6½ inches in maximum width. This nest, 25 feet from the ground, contained an enormous colony of ants, *Camponotus abdominalis* (F.) var. (det. by M. R. Smith). The tree, although leafless at that time, bore many white flowers which were frequented by the ants. We did not know the nest was occupied when we placed it in the back seat of the automobile, but an hour later the truth dawned upon us when we opened our lunch containing half of a luscious Mexican pineapple. The ants had a great propensity for migrating, and for a few days their disappearing and reappearing acts provided rather strenuous entertainment for us en route. Even after we returned home, they somehow escaped from their cage in a room on the second floor and were mourned as lost, until a caller lifted a cushion on the sofa in the parlor and revealed the colony massed beneath it. The colony thrived well in a large tin can for about six months and then began to dwindle, the last ones dying about eleven months after the nest was taken. Unfortunately I had no facilities for observing the behavior of the ants, but in September winged ants appeared in the colony.

All of the nests of *P. occidentalis* contained honey in the cells, sometimes in such large amounts that the bags in which they were placed were soon saturated with it. They also store insects in the cells and between the combs. In British Guiana Dr. Wheeler found termites stored in the nests of this species, and in Panama I found ants of the genus *Azteca* stored in three nests (*l. c.*, pp. 62–64, 1933). Again, all of the ants were males. Among ten nests examined in Mexico, only one contained stored insects; this was a nest of seven combs hanging in the arch of a culvert at Iguala, The ants were identified by Mr. M. R. Smith as *Camponotus* sp. They were also all males and badly mutilated, with all or part of the wings and legs bitten off in various places; just as *P. occidentalis* treated the *Azteca* ants in Panama. Since only one sex was taken in both Panama and Mexico, it is quite likely that ants as food are a luxury to be had only at times when nuptial flights are in progress.

The nests when small are apple-shaped (fig. 21), and only as they grow larger do they become squarely bell-shaped or cylindrical.

I found no parasites or enemies in the nests examined. In the laboratory I bred the Indian meal-worm, *Plodia interpunctella* Hbn.

(det. by Carl Heinrich), from some of the combs, but since Dr. Heinrich writes that this insect is found all over the world, I do not know if infestation occurred in its native haunts in Mexico or in my laboratory.

POLISTES WASPS

Polistes wasps in Mexico have their seasons of activity and of rest. In February 1939 (*l. c.*, pp. 85–88) we found three species in the early stages of nest founding but not many colonies of any of them, for February is near the end of the dry season when all life temporarily follows a slow pace. Even then we found *P. carnifex*, *P. major*, and *P. instabilis* in the act of founding new nests. A fourth species, *P. canadensis* var. *mexicanus*, was taken on the wing and seen abundantly in the air at Cuernevaca; evidently they were at work, although nests were not seen. In contrast to the four species that were alive and at work in February—in July of the following year three of these and five additional species were observed; this makes a total of nine *Polistes* species which I know to inhabit Mexico. Doubtless the literature contains more, and others await discovery.

Polistes carnifex Fab.

Figures 3 and 4

These large nests and their giant wasps, the dread of the natives, were seen in culverts under the highway and under the eaves of buildings at Tamazunchale and Xilitla, in San Luis Potosi, Cordoba and Jalapa in Vera Cruz, and at Iguala and Acapulco in Guerrero. Large colonies as well as newly founded nests were observed in July, the new colonists evidently coming from overpopulated nests elsewhere. That *P. carnifex* has a resting or hibernating period during the dry season was observed in 1939, when no heavily populated nests could be found, but only small new ones of shallow cells with several active queens. These few queens were the forerunners, commencing their nests (probably a month before the end of the dry season) before the rank and file of *P. carnifex* became active.

The large nests are made of heavy gray paper, but all of the small new ones are of thin paper of a yellowish color. The nests always hang horizontally from a central pedicel and are usually founded by several queens. The eggs are deposited while the cells are quite shallow and incomplete, and are enlarged from time to time to accommodate the growing larvae. The completed cells are quite wide (3½ to the inch). The nests of *P. carnifex* are characterized by a steep roof (fig. 3) usually sloping at an angle of about thirty degrees from horizontal; this feature becomes evident even in the small nests (fig. 4). This sloping roof is the character by which the nests of this species may be distinguished at a glance from the flat-roofed ones of *P. major*, which are otherwise very similar. The nests of *P. carnifex* are round and the largest observed—bearing a population of fifty adults—measured 8 inches in diameter. They are made of wood pulp, and adults were occasionally seen biting out bits of weather-beaten wood from posts at Tamazunchale.

Polistes major P. de Beavois

Figure 12

In February, 1939, *P. major* was taken on the wing at Tamazunchale and a newly founded nest was observed at Orizaba. During July, 1940, active colonies of *P. major* were observed at Cordoba, Acapulco, Tamazunchale, and Victoria. The nests (fig. 12) are of a single comb, round, and resemble very much those of *P. carnifex*. Nests of all sizes were observed in July, from newly founded ones with one, two, or three queens, to nests which measured up to 7½ inches in diameter with from 40 to 50 adults upon them. Like the nests of *P. carnifex*, the pedicel is in the center of the roof, but unlike them the roof is very flat. The nests are found under bridges and in culverts, in trees and under the eaves of dwellings. The cap over the cell is of heavy white silk and is made by the larvae before pupating. The cells are used again and again for brood, and as they become less roomy because of the accumulation of excrement left plastered to the ceilings by the succession of young, their length is often increased by the spinning larvae. Sometimes one finds the old cells in the center of the nest measuring two inches in depth, while normally they are but one inch. The cells of *P. major* are a little narrower than those of *P. carnifex* (3½ cells to the inch).

Several nests of *P. major* were parasitized by the moth *Chalcoela iphitalis* Wlkr. The moths emerged from the nests in July.

Polistes pacificus var. **modestus** Sm.

Nests of this wasp were found near Acapulco, Iguala, and in the village of Xaltianguis, Guerrero. The nests are small, round, and made of thin light gray paper. They hang horizontally and have the pedicel in the center of the roof. Each of the six nests taken had from 10 to 16 small (5 to the inch) cells; the cells contained eggs, larvae and pupae.

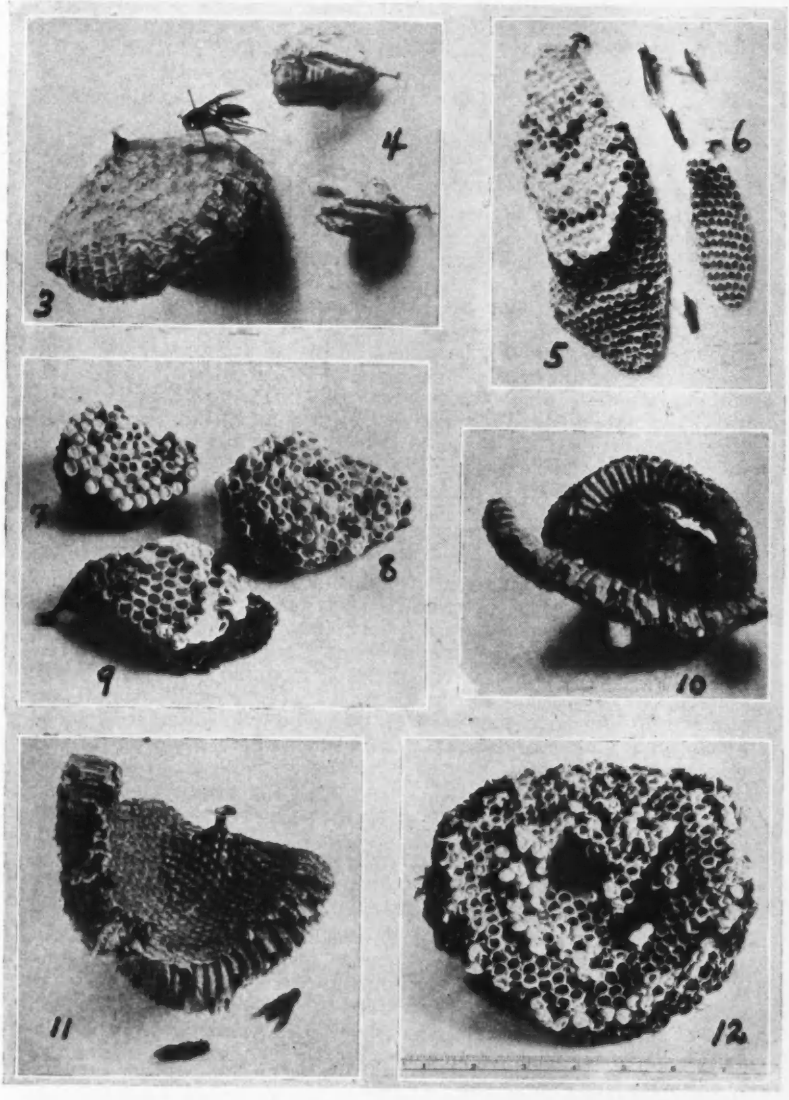
Polistes fuscatus var. **apachus** Sauss.

Figure 15

A nest of this species was found in a culvert at Rio Grande City, Texas, on July 3, 1940, and in the arid region near La Gloria, Neuvo Leon, Mexico. A dozen or more adults in company with other insects, were observed refreshing themselves at a mud puddle. With legs widely spread they deftly alighted on the water, filled their gullets and heavily flew away. The nest taken at Rio Grande City (fig. 15) was round, 2¼ inches in diameter, and contained sixty cells with eggs, larvae or pupae and also had twelve adults on the comb. In width the cells measured a little over one-fourth inch in diameter.

EXPLANATION OF PLATE II

Figure 3. Nest and adult of *Polistes carnifex* (⅓ nat. size). 4. Newly begun nests of *P. carnifex* (⅓ nat. size). 5. Nest of *P. instabilis* (⅓ nat. size). 6. A newly begun nest of *P. instabilis* (⅓ nat. size). 7, 8, 9. Nests of *P. exclamans;* all of fig. 8 and part of fig. 7 parasitized by *Chalcoela iphitalis;* note condition of cells (⅓ nat. size). 10. The work of three generations of *Mischocyttarus* sp. (¼ nat. size). 11. Nest of *Polistes canadensis* (⅓ nat. size). 12. Nest of *Polistes major;* portions in center have been removed for purpose of study.


3
4
5
6
7
8
9
10
11
12

Polistes canadensis L.

Figure 11

Polistes canadensis is not a pretty wasp to look upon; it has the dirty color of dried blood and has not even a band or blotch of color to relieve it of its ugliness. Color forms of *P. canadensis*, such as ***rubiginosis***, ***annularis*** or ***panamensis***, are quite pleasing in color or pattern.

The nests, more or less irregular in shape (fig. 11), were found at Iguala, Acapulco, Pie de La Cuesta, in Guerrero, and at Jalapa, Vera Cruz and Pola Gacho, in Vera Cruz, where they nested in trees, culverts, and under the eaves of native dwellings. Colonies are founded by several queens and in July I found nests in all stages of development. A few nests were also seen which were founded by a single queen. In reference to colony founding I may mention a very large nest with fifty adults upon it under the eaves of a native hut which had, just a few inches below it, a new nest with 104 shallow cells (each with an egg) that had only recently been founded by eight queens—presumably an offshoot from the nearby large nest.

Only six nests were obtained for study and all of them had the pedicel near the top and all hung in a vertical position. The nests are often more or less heart-shaped, owing to the tight quarters in which they are built. The largest was $8\frac{1}{2}$ inches wide and $4\frac{3}{4}$ inches in height. There were $3\frac{1}{2}$ cells to the inch. Unlike some species of social wasps, but very much like that of *P. **annularis***, the larva spins a silken lining to its cell which completely covers the walls from door to ceiling. The larva also often enlarges the cell before it pupates, and does this by placing an addition of silk around the opening. Many species of social wasps in temperate as well as in tropical regions strengthen the pedicel of the nest at its point of attachment by applying a shiny black substance which looks very much like rubber or tar. This substance was more freely used and more thickly spread by *P. **canadensis*** than by any other species of *Polistes* with which I am acquainted. In some nests the entire pedicel, including the flange which holds it to the support, was almost entirely composed of this substance and the roofs as well were covered with it. It was very thick, black and shiny near the pedicel, becoming progressively thinner towards the periphery of the roof. Not only were the wasps the first paper-makers, but apparently they also preceded man in the use of rubberized roofing as well. One nest had certain cells which indicated that the larvae were hosts to a hymenopterous parasite; none of the parasites were obtained, but their spinning work looked very much like that of ***Polistaphaga fulvipes***.

Polistes instabilis Sauss.

Figures 5, 6, and 13

Polistes instabilis, a conspicuously colored wasp, is probably the most abundant of all social wasps in Mexico. We found it everywhere in our travels—at Limon and Victoria in Tamaulipas, at Tamazunchale, Xilitla, and Valles in San Luis Potosi, at Taxco, Iguala, Acapulco, and Pie de la Cuesta in Guerrero, at Cordoba, El Fortin, Jalapa, Vera Cruz,

and Coatepec in Vera Cruz. It nests in trees, in native habitations, on walls and ceilings of culverts, under bridges and under overhanging rocks. In February, 1939, I found no large nests that were occupied, but many small nests in the early stages of founding (fig. 6) with one or more queens upon them. In July we saw nests in every stage of development, newly begun nests with from one to twelve queens upon them to fully colonized nests as large as 8 x 3 inches in diameter. Often a newly founded nest was very near to a large colony, which indicated that the new colony was merely an offshoot from the old one. Many of the shallow cells in newly begun nests contained small drops of honey. The amount of work accomplished in nest building by foundress queens is indicated by the following observations: three queens started a nest in a doorway at Tamazunchale; this and two subsequent nests built in the same place by these queens were knocked down by the owner of the place. I saw the beginning of the fourth nest as I was leaving Tamazunchale, and when I returned eighteen days later I found that the three queens had built a fourth nest during that time. This was 3 inches long and ½ inch wide, and had 41 shallow cells which contained eggs.

The nests of *P. instabilis* are more or less pear-shaped (fig. 13) although they are sometimes diamond- or finger-shaped (fig. 5); they hang in a vertical position and have the pedicel at the very top. Many nests have the pedicel and a portion of the comb near it more or less thickly covered with the black rubbery substance described for *Polistes canadensis*; one small nest had an extremely heavy coating of it on the top, sides, and back of the nest. The number of cells to the inch was four to four and one-half.

This species suffered very much from the onslaughts of the lepidopterous parasite *Chalcoela iphitalis* Wlkr. Out of 56 nests collected, 24 were parasitized, and these to the extent of from 10 to 100 per cent of the cells.

Polistes exclamans Viereck

Figures 7, 8 and 9

Polistes exclamans is not a Mexican wasp, but deserves to be included in this list since it is found close to the Mexican border. Colonies were observed in Texas at Rio Grande City, Austin, Artesian Wells, Dennison, Mission, Pleasanton, Sherman and Waco. *P. exclamans* resembles *P. instabilis* very much in color and form, but there is a slight difference in the shape of the nests. There are also slight anatomical differences, for Dr. Bequaert writes: "The specimens which I have called *exclamans* are all from Texas, while those which I have called *instabilis* are all from Mexico. The two species are exceedingly similar. It is possible to distinguish between the males without much doubt, but females and workers can scarcely be told apart; there is, however, a slight difference in the shape of the head; the eyes in *P. instabilis* females being more bulging than in the *P. exclamans* females."

This species nests in culverts, under bridges, in thickly matted vegetation as well as in sheds, porches and under the eaves of buildings. Nests in all stages of development were found on July 3 in our drive

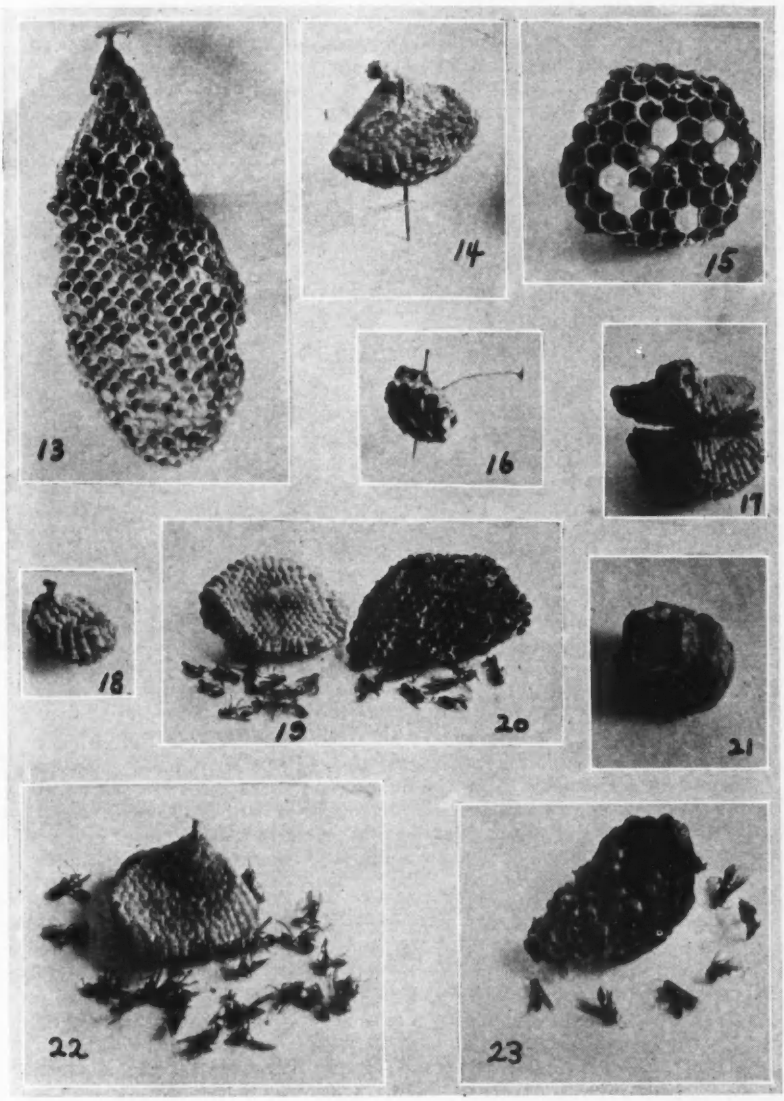
from Mission to Rio Grande City; some were small and newly founded with one or a few queens, and some were quite large. The largest, which was fan-shaped because of the crowded corner in which it was built, measured 4¼ x 3¼ inches in diameter. Most of the nests measured roughly about 3 x 2 inches in diameter. Even though the summer was only half over it was evident even at this time that this species does not make nests of giant size; of the large number of empty last seasons' nests collected the largest measured only 4 x 5 inches in diameter. Here too, as is so common with tropical *Polistes*, swarming and pleometrosis occurs; almost all of the newly founded nests were very close to large colonies from which they evidently had their origin, and almost all of them were founded by several queens. Most of the nests were attached to flat surfaces, but in an open shed at Rio Grande City I found three large nests hanging from a wire which was tightly stretched near the ceiling. In the same shed I found also a large misshapen nest with a hundred wasps upon it, crowded under the handle of a piece of machinery, and just a few inches below it a newly founded one of shallow cells with 50 adults upon it. Whereas the nests of *P. instabilis* are almost always pear-shaped and hang in a vertical position (figs. 5, 6, 13), those of *P. exclamans* are almost always round or irregularly round, or irregularly oblong (figs. 7, 8, 9), and even though the pedicel is at the edge of the roof the nest usually hangs in a horizontal position. The pedicel of the nests of this species is only slightly rubberized. The number of cells to the inch varied from 4¾ to 5. Several cells in several of the nests contained drops of honey. When the adults of the colonies were examined on July 3, I found many males among them.

Many of the nests of *exclamans* were parasitized by the moth *Chalcoela iphitalis*, and in some nests the infestation was as much as 95 per cent of the cells (fig. 8). The moths emerged as adults during July.

The larvae of this wasp secrete an enormous amount of silk; not only do they spin the silken caps to the cells, but they also thickly line the paper walls of them to the very ceiling with it, and also often increase the size of the cell by adding a ring of silk to it. It seems to me that a study of the spinning activities of social wasps would reveal facts of great phylogenetic significance, since the solitary wasps (Sphecidae) from which they evidently have evolved are known to spin silken cocoons.

EXPLANATION OF PLATE III

Figure 13. Nest of *Polistes instabilis;* lower cells parasitized by *C. iphitalis;* upper cells resealed with mud, leaf-paste or resin, by *Stenodynerus mystecus, Zethus pipiens* and *Megachile* sp., respectively (½ nat. size). 14. Nest of *Mischocyttarus immarginatus*, showing layer of waterproof substance on roof near pedicel (½ nat. size). 15. Nest of *Polistes fuscatus* var. *apachus* (½ nat. size). 16. Nest of *Mischocyttarus labiatus;* note long, thin pedicel (½ nat. size). 17. The work of two generations of *Mischocyttarus* sp. (½ nat. size). 18. Nest of *M. pallidipectus* (½ nat. size). 19. Nest and adults of *M. basimacula* (½ nat. size). 20. Nest and adults of *M. immarginatus* (½ nat. size). 21. A newly begun nest of *Polybia occidentalis* (½ nat. size). 22. Nest and adults of *M. cubensis* var. *mexicanus* (½ nat. size). 23. Nest and adults of *M. ater* (½ nat. size).


13
14
15
16
17
18
19
20
21
22
23

MISCHOCYTTARUS WASPS

All members of the genus *Mischocyttarus* build nests of paper but in some species the finished product is light-weight and papery, resembling somewhat in texture the nests of *Polistes* wasps, while in others the comb is smooth, firm, brittle, closely-knit and looks very much like stiff thinly glazed cardboard. In the latter instances the pulp which goes into the making of the nest is evidently subjected to a more thorough process of mastication with probably, also, a more liberal amount of saliva or other important ingredients added.

In Mexico those species which I observed that make papery nests are *M. pallidipectus* and *M. basimacula*. Those which make cardboard nests are *M. immarginatus*, *M. ater*, *M. cubensis* var. *mexicanus* and *M. angulatus* var. *ictezicus*. There is another species, *M. labiatus*, that make a nest whose texture is of an intermediate grade, for while it resembles rough cardboard, the material is so thinly spread and so loosely put together that it cannot be placed in either of the two categories.

In tropical regions of Mexico such as Cordoba and Tamazunchale, one would expect to find colonies of social wasps such as these to be perennial, *i.e.*, existing from year to year and throwing off the surplus population in swarms as "lebensraum" demands it. This, however, is not the case for these wasps, for while they lose a portion of the population from time to time for the founding of new nests, the colonies themselves come to an end before the coming of the dry season, and the survivors that are to perpetuate the race go through a resting period which is probably very much like the hibernation of northern wasps. This period of hibernation in Mexico coincides with the dry season which ends in May; however, long before the end of the dry season some members of some species come out of their torpor and found new nests. This was found to be true for four species of *Mischocyttarus* wasps which began their nest building in February (Ann. Ent. Soc. Amer., 33: 82–92, 1940).

In July 1940 I found the nests of members of this genus much more abundant, of much larger size, and with larger populations upon them than in February 1939, when the nests were first begun. Naturally one would expect this to be the case, but it is here mentioned since it points to a seasonal activity instead of a perennial condition.

In addition to renewing my acquaintance with the four species seen in 1939 (*M. immarginatus*, *M. ater*, *M. basimacula*, and *M. cubensis* var. *mexicanus*), three additional species, *M. pallidipectus*, *M. labiatus*, and *M. angulatus* var. *ictezicus*, were observed, making a total of seven species in my experience with Mexican *Mischocyttarus*. It is to be regretted that time was not at hand to study the minute details of behavior of the various species, for they offer to the naturalist many problems in behavior, phylogeny and ecology, which may only be solved by residence in one place for several weeks or by frequent visits to certain nests over long periods of time. Some of the problems to intrigue one are: How, why, and when do they hibernate? What is the caste system, if any? What materials go into the building-pulp and how is it manipulated by each species? To what extent is honey

used as food for the young and what insects, if any, are used as food for the young? If insects are used how are they captured and transported to the nest? These and many other problems offer a rich field to the young and enthusiastic naturalist. However, all is not in complete darkness; some few details on life history have been observed on seven species of these wasps, as the following pages indicate.

Mischocyttarus pallidipectus Sauss.

Figure 18

Three nests of this wasp, a black insect with delicate yellow bands on the abdomen, were found on the underside of the bridge spanning Rio del Tecalpulco, near Iguala, Guerrero. The nests (fig. 18), (each a single comb, with the pedicel at the edge of the roof) were constructed of light-weight brown paper and hung horizontally. They were round or oblong in shape and the three nests measured ½ x ⅞ inch in diameter, ⅞ x ⅞ inch and 1½ x ⅞ inches, respectively. The nests contained 17, 25, and 30 cells. In measuring the width of the cells I found that there were six to the inch. There were only one or two adults upon each nest, and it appears that this species commences nest building late in the season. I do not think that colonies of this species ever attain great size.

Mischocyttarus labiatus Fab.

Figure 16

The nest of this species never attains great size; it is merely a small cluster of *Polistes*-like cells dangling from a long, thin, wire-like pedicel (fig. 16). The pedicel is attached to the center of the roof. Two of the nests of this species were removed from overhanging rocks along the road next Xilitla, San Luis Potosi, on July 8. There was one adult on each nest, but both flew away when an attempt was made to obtain them. Since no specimens were taken I cannot be absolutely sure about the accuracy of the identification; however, the nests and adults looked very much like the *M. labiatus* whose acquaintance I made in Panama some years ago (Jungle Bees and Wasps of Barro Colorado Island; fig. 62). Both nests were round, contained 16 and 26 cells respectively, measured an inch in diameter, and hung bell-like from a thin strong pedicel 1¼ inches long. The pedicel was not composed of the same material as that of the nest, but seemed to be very much like the rubbery material used for pedicel reenforcement by *Polistes* wasps, mentioned in previous pages. The nest itself was made of roughly masticated wood pulp of gray and brown color (both colors appearing in each nest) having mixed with it bits of unchewed wood which was easily discernible with the hand lens. This same condition of rough grains and bits of unchewed wood in the building material was also noticed in the Panama nests already referred to.

Mischocyttarus ater Olivier

Figure 23

At Cordoba in February 1938 I found a single queen in the act of building her first cell (*l. c.*, p. 90), and in the immediate vicinity of this

nest I found in July 1940 two fairly populous colonies of this species. The wasps are large in size when compared with other members of the genus, and have black bodies with black wings. The only relief from somberness is an area of dirty white on the tip of each wing. This is at first not noticed, but the lighter area soon looms up conspicuously when the wasps nervously flit the wings as they move about the nest. I noticed that the wings were often half raised and were flitted so often and so jerkily and with what appeared to be conscious effort, that I concluded that this was done for my benefit as well as to serve as a warning signal to other members of the colony.

The nests, solidly made of finely masticated cardboard, are dark brown in color and serve admirably as a protectively colored background for the black wasps, for the white tips of the wings are not at all prominent as they normally move about the nest. The nests were in horizontal positions attached by short stout pedicels to the stone arches of an old building (fig. 23). The smaller nest, composed only of shallow cells with six queens upon it, was in the early stages of founding, and the colony had evidently swarmed from the larger nest twelve feet away. I arrived at this conclusion because the larger nest seemed to be at the point of breaking up, for even though there were 23 adults upon it there were only a few immature wasps in the cells (most of the cells were empty) and no new cells were in course of construction. The larger nest was irregularly semicircular (evidently due to the fact that it had been started too near to the pillar of the arch) and measured at its widest points 2½ x ½ inches in diameter. There were about 95 cells in the nest and these measured five to the inch.

Judging from the observation in 1939, one may aptly say that the present large colony had its inception late in the dry season (perhaps also in February), and after developing for five months was in the final stages of decline and disbandment. With the end of the season yet several months away, the newly founded nest indicates that colony founding and development will continue for sometime. Instead, therefore, of having at the end of the season one large colony, we will have a number of small ones; all offshoots more or less remote from the main nest. Just why several small colonies should be better than one large one is anybody's guess. To me, at least, one method does not seem to have any advantage over the other for, quite likely, the number of queens which go into hibernation at the end of the season will be the same either way.

Mischocyttarus basimacula Cameron

Figure 19

Colonies of *M. basimacula* were taken in July at Cordoba, Jalapa and Coatepec in Vera Cruz, and in February of the previous year a newly founded nest of 42 cells and 3 queens was taken at Tamazunchale (*l. c.*, p. 90). The nests of this wasp are made of thin brittle paper and are of a pale yellow color, matching almost completely the yellow color of the wasps. One only realizes how closely the wasps resemble the nests when one attempts to take them. The nests (fig. 19) are round or irregularly oblong and do not attain great size; the largest of the eight nests taken measured 1¾ x 2 inches in diameter, and contained about

60 cells. The cells are not very wide (seven to the inch). Colonies are founded by one or many queens, and newly founded colonies were seen in July as well as (as already mentioned) in February. The number of adults on the nests in July was quite large, and the 60-cell nest referred to above had 22 adults upon it when taken. The nests were attached to walls of culverts and sometimes to old paper nests of their own and of other species. Three of the eight nests taken were parasitized by the moth *Chalcoela iphitalis* Wlkr., the infestation amounting to 10, 25 and 50 per cent respectively of the immature population.

Mischocyttarus angulatus var. **ictezicus** Richards

Three nests of this species were taken under bridges over Rio de Tecalpulco near Taxco, Guerrero, and Rio Popagayo on the road to Acapulco. The adult wasp is small and of a yellowish color and the nest is made of stiff brown paper. The nests in the middle of July were small, having only from 8 to 15 cells and with only from one to five adults on them. It is not known if pleometrosis exists in this species.

Mischocyttarus cubensis var. **mexicanus** Sauss.

Figure 22

Four nests of this species were taken at Valles, San Luis Potosi, and Iguala, Guerrero, although in the previous year in February they were taken at Limon and Victoria in Tamaulipas (*l. c.*, 90–91), where they were in the early stages of nest founding. The nests (fig. 22) are made of light-weight cardboard and hang in horizontal positions. The shape of the nest may be round or oblong, with the pedicel placed near the edge of the roof. One round nest measured 1¾ inches in diameter and on July 6 had 30 adults upon it; another, an oblong one, measured 1½ x ½ inches in diameter and had 7 adults upon it; the third, with 10 adults, measured 2 x 1 inches. The cells measure 6 to the inch. Apparently new nests are begun at any time of the season, for we found newly founded nests in July 1940, as well as in February of the previous year.

Mischocyttarus immarginatus Richards

Figures 14 and 20

This is the new species recently described by Dr. O. W. Richards, in part from material collected by me in February 1939. A technical description of the species appeared in Annals and Mag. of Nat. History, Series 11, 5: 182–183, 1940, and an account of its nesting behavior in Annals Ent. Soc. America 33: 91–92, 1940. On my first visit to Mexico, colonies of this wasp were observed at Canyon de Galana, Valles, Victoria, Tamazunchale, and Cordoba. In July 1940 they were observed at Xilitla and Tamazunchale, in San Luis Potosi, Taxco, Iguala, Mexcala, Acapulco, and Pie de La Cuesta in Guerrero, Limon and Victoria, in Tamaulipas, and Cordoba in Vera Cruz, and Richards (*l. c.*, p. 83) records it also from Chichen Itza, Yucatan, and from Managa, Nicaragua.

The nesting sites of this species are in culverts under the highway, under bridges, under overhanging rocks, in the eaves of native huts, in

the doorways and window frames of modern tourist camps and in open faced sheds. The nests were quite large in July; this was to be expected, since building operations commence during the latter part of the dry season. The nests are founded by one or by several queens and the size of the nest is probably in proportion to the number of queens which found it. The shape of the nest is round, oval, or oblong, but one often finds a nest of irregular shape (fig. 20) due to the cramped quarters in which it is placed. When operations are started too close to a wall the result is a nest which is semicircular; when it is commenced in an angle of two walls the resulting nest is fan-shaped; when placed in crevices among rocks the finished nest is very much mis-shapen. The nests always hang in a horizontal position and are attached to the supports by a short stout pedicel, usually centrally placed on the roof of the nest, but sometimes placed considerably off center. The size of 22 nests collected in July varied from approximately 2 x1½ inches in diameter to the largest which measured 3½ x 2½ inches; most of the nests, however, measured about 2 x 1½ inches, more or less. These measurements do not include the small newly founded nests, several of which were seen at the time. The season had yet several months to go before its end, and the colonies as well as the nests would have become larger before the coming of the dry season had they not been disturbed. However, the largest nest taken from last year's crop measured only 4½ x 4½ inches in diameter, and it is doubtful if nests of this species ever attain greater size.

The nests are solidly and substantially built, and the finished comb resembles smooth cardboard. So closely-knit is the pulp that one suspects it is thoroughly worked up in the mouth and heavily mixed with saliva before being used as building material. One sometimes wonders if vegetable gums are not also used in the process, for the finished product is so much in contrast with similar work of a sister species, *M. labiatus*.

The roofs of the nests are undoubtedly made waterproof by the spreading of a substance which I think is saliva mixed with certain vegetable juices. This hardens into a thin, transparent, shiny layer of onionskin-like substance which may be picked off in small patches with a pin point (fig. 14). In some nests, however, this roofing veneer is so thin that one needs a hand lens to see it. It was at first thought that this material was a silk substance, but the microscope proved it to be not so. In one nest in particular this layer was unusually thick around the pedicel and actually entirely covered it. It covered the entire roof also, but became progressively thinner as it neared the edges, and yet still thinner as it went over the edges and spread over the outside row of cells, where (thin as it was) it was still sufficiently shiny to be easily recognized. Sometimes the roofs were thickly covered with this hardened spittle, sometimes thinly so, and sometimes it did not appear at all. Since all of the nests were taken from amply protected situations in man made structures, I suspect that the behavior of waterproofing the roofs—if that is what it actually is—is a vestige from the time when the wasps were compelled to place their nests in positions exposed to the elements.

The wasps of this species return to the home site after hibernation and found new nests near the old ones. They sometimes even attach the new nest onto the old one. Nests of this kind may be seen in figures 10 and 17, where three and two annual generations respectively have built in this manner, and other cases of this kind may be seen in Ann. Ent. Soc. Amer., 33: 93, 1940, figures 1 and 2. It is of interest to note that like *Polistes* wasps, this species never uses a nest for a second season, and also like *Polistes* wasps, they always gather fresh building material for each nest, instead of obtaining it the easy way by dismembering and rechewing the walls of a nearby old nest.

The larvae of this species, like those of all social wasps, spin silken caps over their cells before pupating. In *Polistes* wasps, these caps are always conspicuous by their whiteness. In *M. immarginatus*, however, the caps are of the same brown color as the rest of the nest. The workers are responsible for this color condition, for it was noticed that the newly spun caps are white, and that after a time the workers cover them with a thin layer of brown saliva which probably contains dissolved wood pulp. The larvae spin caps that are very thin, and the additional layer probably serves to conserve moisture for the larvae. The number of adults on the nests in July varied from 12 to 25.

The cells were about one-half inch deep, and in width there were 5¼ to 5½ cells to the inch.

The nests of this species were free from the lepidopterous parasite *Chalcoela iphitalis*, which is a menace to other social wasps in Mexico. An enemy of this species, I was told, is a marauding ant, which occasionally completely exterminates a colony.

EUMENIID WASPS

Odynerus pratensis Sauss., and **O. verus** Cress.

In the arid region north of La Gloria, Neuvo Leon, several dozen wasps of both *O. pratensis* and *O. verus* in company with the similarly colored *Polistes fuscatus* var. *apachus* frequented a water puddle near a well, where they quenched their thirst and also carried away great gulletfuls of water. Several species of Lepidoptera, as well as several individuals of a small *Trypoxylon* wasp were there, also refreshing themselves. The Eumeniids always alighted on the surface of the water with outstretched legs, and they remained in this position for several minutes without any fatalities occurring.

Odynerus hidalgo Sauss.

Two dead specimens of this species were found in old cells of the mud-dauber, *Scelephron caementarium*, taken near the Mexican border at McAllen, Texas. These wasps, like so many sister species, use the cells of discarded mud nests for their own young.

Pachodynerus nasidens Latr.

A wasp of this species was taken on flowers at Tierra Colorado, Guerrero, July 15, 1940. Dow (Psyche, 39: 12, 1932) found this wasp in Cuba nesting in the discarded cells of the mud-daubing wasp. He

reports that caterpillars are used for food for the young, that the egg is suspended in the cell by a silken thread, and that the cocoonless larvae cover the walls of the cells with a transparent layer of shiny silk.

Ancistrocerus bravo Sauss.

One adult emerged from an old cell of the mud-dauber, *Scelephron* sp., on August 2, 1940. The nest was taken a few weeks earlier near Jalapa, Vera Cruz.

Ancistrocerus guzmani Sauss.

At twilight on the road to Vera Cruz, an aggregation of six of these wasps, all males, was found asleep on a delicate rootlet protruding from a bluff. The rootlet was in a vertical position and the wasps were strung on it one below the other, all with heads up and about an inch apart. On a parallel rootlet a few inches away was another aggregation of a half dozen wasps, all males, but of another species, *Chalybion zimmermanni*. The latter species has cuckoo-like habits. It is noteworthy that even though the sleeping quarters were close to one another, there was no mingling of the species.

Stenodynerus mystecus Sauss.

Figure 13

This species uses the old empty cells of *Polistes instabilis* and of *Mischocyttarus* sp. as brood chambers for its young. It is a worker in mud, using this material for making partitions and for sealing the entrances. The cells in the *Mischocyttarus* nests measure three-eighths to one-half inch in depth, and an entire cell is used for each young. The cells are considerably larger, however, in the nests of *P. instabilis* and one cell usually serves for two brood chambers when a mud partition is placed across the middle. Sometimes, however, the mud wall is placed a little distance from the entrance; in such cases there is a vestibule or empty air pocket near the plugged opening; sometimes the wall is placed near the ceiling, and then the little room entombs the rubbish left in the cell by a previous occupant.

The larvae feed on caterpillars provided in mass provisioning by the mother; in each of six cells in which the eggs failed to hatch I found from 12 to 16 very small caterpillars. These were so lightly stung (or probably not stung at all) that many of them pupated; later some of the latter actually transformed into adults. The adults were identified as *Scythris* sp. (Scythridae) (det. by J. F. Gates Clark).

Many species of Eumeniid larvae, before preparing for pupation, apply a thin veneer, probably of silk, to the walls of the cells. The walls are covered more or less completely according to the species, but in *S. mystecus* the amount of veneering is indeed very small and is wholly confined to the inside portion of the plug or the partition, which, incidently, happens to be the point nearest the mouth of the larva.

S. mystecus were only found near Iguala and Mexcala, Guerrero. In a large old nest of *P. instabilis*, 20 cells were used by *S. mystecus* and in the three nests of *Mischocyttarus* sp., 27, 30 and 110 cells respectively were used by this Eumeniid wasp. The nest with 110 cells, however,

was the crowning glory of the series for it gave forth 93[2] adults which emerged between July 15 and 30 with, in addition, a few stragglers emerging between September 1 and 22. Many fully developed wasps were unable to break their way through the mud plugs, although when the plugs were examined it was evident that attempts were made by the young adults to bite their way to liberty. This difficulty in emerging might be due entirely to laboratory conditions, for each nest was kept in an almost airtight cellophane bag; under natural conditions enough moisture would have been absorbed by the mud to make normal emergence possible.

S. mystecus seems to be easy prey for several species of parasites. Several chalcid parasites, *Monodontomerus montivagus* Ash. (det. by A. B. Gahan) emerged from the cells August 28 to September 5. A fully formed dead braconid parasite, *Bassus gibbosus* Say (det. by C. F. W. Muesebeck) was found in one of the cells among dried caterpillars; according to Dr. Muesebeck, *B. gibbosus* is only parasitic on lepidopterous larvae, and it is assumed, therefore, that the host was the caterpillar prey, *Scythris* sp. and not the wasp larva. Two cuckoo-wasp parasites, *Chrysis* sp., emerged from the cells on July 15 and 20. A dipterous predator, *Toxophora virgata* O. S. (det. by C. T. Greene) emerged from one of the cells on August 3, and a dead adult dipterous predator, *Leucopis* sp. (det. by C. T. Greene) was found in one of the cells.

Zethus aztecus Sauss.

One specimen was taken on a flower at Limon, Tamaulipas, July 25, 1940.

Zethus pipiens Zavattari

Figure 13

This species, like *Stenodynerus mystecus*, uses the empty cells of *Polistes* and *Mischocyttarus* nests as brood chambers for their offspring. They gather and use a green vegetable material, which they thoroughly masticate, for partitioning the cells and plugging the openings.

Z. pipiens and *S. mystecus* often use the same paper nest at the same time for their broods, but the work of each can easily be identified because one uses green vegetable pulp and the other uses yellow mud. The green vegetable material used by *Z. pipiens* is thoroughly worked over and when dry is as hard as the mud plugs of *S. mystecus*. In several nests I found cells of both species side by side, but in every case the cells of *S. mystecus* greatly outnumbered those of *Z. pipiens*. In two of the nests a third insect—a resin-using Megachile bee (new species)[3] occupied some of the old cells.

The nests containing *Z. pipiens* were found only at Mexcala and Acapulco, Guerrero. The nests were collected during the middle of July and adult wasps emerged 10 to 14 days later. Three nests disclosed 13, 6, and 3 *Z. pipiens* respectively, and several of them in each nest were unable to bite their way through the hardened plugs of leaf paste.

[2]Dr. Bequaert has kindly examined the 93 wasps to ascertain the proportion of sexes. He reports 44 males and 49 females.

[3]A description of the new species is soon to be published by Dr. T. B. Mitchell.

The brood-chambers in the old *Mischocyttarus* nests were near the ceiling, and consumed about two thirds of the available space, while the lower third near the doorway was unoccupied and appeared to be an air chamber. When the larger cells of *Polistes instabilis* were used the brood chambers of *Z. pipiens* (three-eighths inch in length) were near the openings, and the rest of the cell walled off with a plug of leaf pulp one sixteenth inch thick.

The old cells of *Mischocyttarus* sp. are used over and again, generation after generation, by *Z. pipiens*; the young wasps evidently build in the very cells from which they emerged. This same behavior was also recorded for its neighbor *S. mystecus*, and sometimes a cell is used one year by one species and the next year by the other, for we often found exit holes in mud plugs which were resealed with green leaf pulp—indicating that after *S. mysticus* had bitten its way to freedom along came a mother *Z. pipiens* and appropriated the cells for her own brood, leaving the telltale bit of green in the doorway.

STONEFLIES OF SOUTHWESTERN BRITISH COLUMBIA, by WILLIAM E. RICKER. Indiana University Publications, Sci. Ser. No. 12, 145 pages, 129 figures. 1943. For Sale, Ind. Univ. Bookstore, Bloomington, Ind. Price, $1.50.

Professor Ricker, now of the Zoology Department of Indiana University, is well known in his various studies of Canadian stoneflies, first while at the University of Toronto and later in British Columbia while serving the Fisheries Research Board of Canada and (1938) the International Pacific Salmon Fisheries Commission.

The present study is one of the most complete and detailed yet made of the stoneflies of a small area. While in taxonomic form it considers types of streams, water temperatures and seasonal distribution. Forty-four pages are devoted to the general problems of the plecopterous fauna of that region, and the problems of its classification. Pages 45 to 142 are devoted to keys and descriptions of species. In the final study of species the author had the use of the extensive collections of the Illinois Natural History Survey.—C. H. K.

THE LEAFHOPPERS OF MINNESOTA (HOMOPTERA: CICADELLIDAE), by JOHN T. MEDLER. University of Minnesota Technical Bulletin 155, June, 1942, 196 pp., 9 plates.

This bulletin is presented with the hope that it will serve as "a convenient and useful manual for the systematic and economic worker concerned with the forms of the upper Mississippi Valley." References to the original description are given for each name used, and keys presented for separation of species, genera and supergeneric groups. A brief diagnostic description of each species appears with distribution and host records. In addition to the systematic treatment there is a list of the literature cited and indices of plant and leafhopper names are included.

The arrangement with respect to subfamilies initiates use of a number of names new in this category. Mr. Medler acknowledges the assistance of Dr. P. W. Oman in his arrangements and that it is in part drawn from Dr. Oman's unpublished work. However it seems unfortunate that inasmuch as some of the changes are rather drastic, no explanation as to why they are so used is offered.

By bringing into readily available form records on the leafhopper fauna of this region, the bulletin will undoubtedly fulfill the hope of its author as expressed above.—DOROTHY J. KNULL.

ANATOMY AND HISTOLOGY OF THE FEMALE REPRODUCTIVE ORGANS OF HABROBRACON JUGLANDIS (ASHMEAD)

(Hymenoptera, Braconidae)[1]

JOSEPH CHRYSTAL BENDER,
Summit, New Jersey

The development and the morphology of the ovaries of *Habrobracon juglandis* (Ashmead) have been described in some detail by various investigators (Genieys, 1925; Henschen, 1928; Speicher, 1931; Whiting, 1940). Of the other organs of the female reproductive system, or "Geschlechtsapparat," no adequate account could be found in the literature. The author's original intention, that of studying the development of these other components of the reproductive system, was therefore abandoned for the time being, in favor of a detailed study of their gross and microscopic anatomy. It is hoped that this study may in part better familiarize those interested in this insect with the morphology of its reproductive organs.

The organs that, in addition to the ovaries, comprise the female reproductive organs are the spermatheca and spermathecal glands, the lubricating gland, the poison glands, and the sting itself. Although these organs are, in their general morphology, typical of Hymenoptera, they differ in many details of structure and arrangement.

The illustrations in this paper should be considered an integral part of the study, for in many cases they speak much more clearly than the text.

Throughout this paper where homologies have been recognizable between *Habrobracon* and other related forms, I have employed the terminologies as set forth by Snodgrass.

MATERIALS AND METHODS

The material used for observation consisted of two wild-type stocks No. 25 and No. 33, which were reared in incubators at 28° C. at the University of Pennsylvania Zoological Laboratory.

Dissections of freshly killed females were made in insect Ringer's solution[2] under the Greenough binocular at a magnification of 50×. A small drop of Tergitol added to the Ringer's at the time of dissection greatly facilitated operations by cutting down surface tension on the cuticle. A foot-focusing device was found to be of much assistance. Operations were usually performed by snipping off the abdomen, cutting away the cuticle with micro-scissors, and dissecting with two

[1]The author wishes to acknowledge his gratitude to Dr. and Mrs. P. W. Whiting for supplying the insect stocks used in this study, to Dr. A. G. Richards for helpful suggestions, and to Dr. R. G. Schmieder for his generous assistance and advice.

[2]Formula by Ephrassi and Beadle for insect Ringer's solution: NaCl, 7.5 grams; KCl, 0.35 grams; $CaCl_2$, 0.21 grams; H_2O, 1000 cc.

pairs of extremely fine, No. 5, Swiss watchmaker's forceps. These were found to be useful because the tracheae, woven tightly in and around the organs in question, could be carefully torn away without disturbing the other organs.

Whole mounts were often prepared from such dissections by fixing in Kahle's (F. A. A.) or B-15, staining in either haemalum or alum cochineal, dehydrating in alcohols, clearing in cedar oil, and mounting in balsam. Whole mounts stained in Sudan III (in 70% alcohol) were run quickly down the alcohols to water, mounted in Apathy's gum syrup.

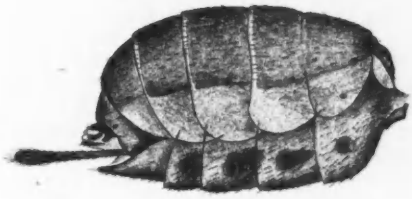
Sectioned material was fixed in Kahle's or in B-15. Since only certain abdominal organs were to be observed, the entire abdomen was cut off and most of the body wall removed. Dehydration and clearing were accomplished by the regular alcohol-xylol method, specimens imbedded in paraffin and then sectioned at 8-10μ. Slides were stained with Delafield's haematoxylin, Heidenhain's haematoxylin, Mallory's Triple, and by the Feulgen method.

EXTERNAL STRUCTURES

Ovipositor and Associated Parts.—Externally the abdomen of the female exhibits eight tergites and five sternites (fig. 1). The first tergite actually represents the tergite of the second abdominal segment, for the first segment (propodeum) is combined with the thorax. The first sternite is composed of the second and third segments fused together. The ovipositor extends from the end of the abdomen, between the proctiger and the seventh sternite. The seventh sternite, known as the subgenital plate, projects slightly caudad beneath the base of the ovipositor. The ovipositor is made up of three pairs of valvulae: the first pair are lancets, the second pair are fused into a median sheath, the third pair are palpi. Externally, only the third valvulae are visible, for they ensheath the first and second valvulae between their hollowed inner surfaces. Together the first and second valvulae present a single dart-like structure, known as the sting. The first valvulae are grooved on their dorsal surfaces and ride on rails of the second valvulae (fig. 2A). The distal ends of the first valvulae are barbed (fig. 3) and lie together not attached to the second valvulae but partially ensheathed by them (fig. 2B). The distal tip of the fused second valvulae is somewhat enlarged and slightly decurved. The first and second valvulae are so constructed as to form a space between them, the poison canal (figs. 2A and 2B), through which both the poison and the eggs pass to the outside. The other cavities seen in these valvulae are extensions of the body cavity and do not open externally. Embryologically, the second valvulae arise as two distinct parts which fuse into one, as is shown by the two cavities of the undivided second valvulae meeting toward the tip.

EXPLANATION OF PLATE I

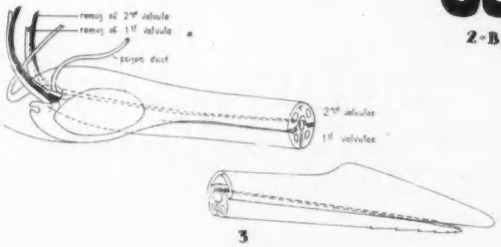
FIGURE 1. External view of abdomen. 2A. Cross-section through 1st and 2nd valvulae, at center. 2B. Cross-section through 1st and 2nd valvulae, at tip. 3. Details of 1st and 2nd valvulae. 4. Sagittal section of female abdomen, showing relationship between organs of the sex apparatus.



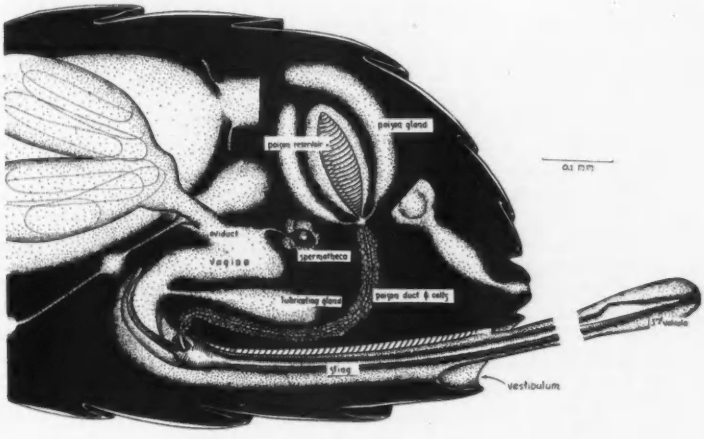
1

2-A

2-B


ramus of 2nd valvula
ramus of 1st valvula
poison duct
2nd valvulae
1st valvulae

3


poison gland
poison reservoir
0.1 mm
oviduct
Vagina
spermatheca
lubricating gland
poison duct & cecity
1st valvula
sting
vestibulum

4

A cavity, the vestibulum (fig. 4) leads cephalad under the bases of the valvulae above the seventh sternite. The vestibulum arises embryologically from the caudad extension of the seventh sternite (Snodgrass, 1933). This cavity continues anteriad above the two most posterior sternites. The bases of the third valvulae, which lie in the vestibulum, are known as the second valvifers (fig. 5). The anterior end of each second valvifer makes a dorsal and then a posterior turn on itself, thus presenting a somewhat triangular projection. Along the posterior aspect of this triangular plate is another small plate, the first valvifer (fig. 5). On the dorsal aspect of this plate articulate two large but thin chitinous lateral plates (fig. 5). These are the anterior continuations of the ninth tergite and they laterally overlap the second valvifers.

Between the anteriormost portions of the second valvifers, which are there somewhat flattened out and curved in towards each other, lies the enlarged proximal end of the second valvulae, the bulb (fig. 5). The bulb is formed from the enlarged bases of the second valvulae, each of which possesses a notch in which the lateral bases of the second valvifers articulate. Between each lateral swelling of the bulb on the dorsal side is a single short central arm, which makes a U-turn back on itself (fig. 3) and serves as an object of attachment for some of the large muscles operating the movements of the ovipositor. From the inside of each lateral swelling of the bulb of the second valvulae a fine ramus curves upward and caudad to attach along the dorsal margin of the corresponding second valvifer (fig. 3). Basal rami from both first valvulae also curve outward and then caudad alongside the rami of the two second valvulae, to make the same attachment.

When the insect is in the stinging or egg-laying position, the distal end of the rigid sting shaft is brought around into an almost anterior direction. The third valvulae bend readily at their connection with the second valvifers, so that the sting shaft is clasped between the third valvulae only at the very distal end of the latter. The first valvulae dart back and forth on their rails alternately and thus work their way through the body wall of the caterpillar host.

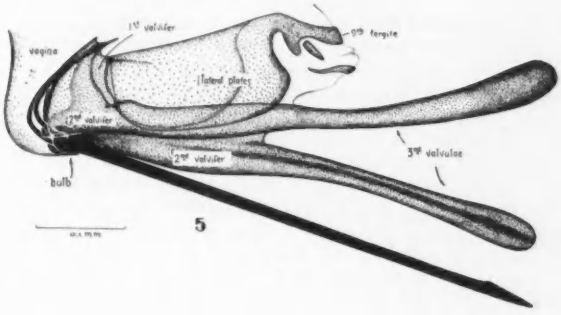
INTERNAL STRUCTURES

General Structure (fig. 4).—In a mature female containing ripe eggs the ovaries occupy the main bulk of the abdomen. The two ovaries, each one consisting of two ovarioles, occupy lateral positions on either side of the mid-intestine. The developing eggs and their nurse cells may be seen along the course of the ovarioles, as well as mature ova that are stored in their sac-like posterior portions. Ventral to the mid-intestine the two parts of each ovary continue as right and left oviducts, respectively. These meet under the large posterior ganglion in a com-

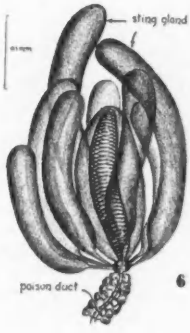
---

EXPLANATION OF PLATE II

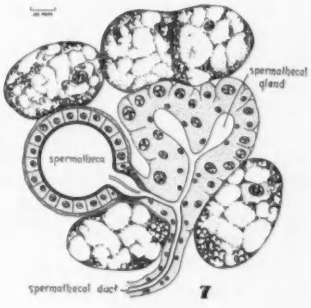
FIGURE 5. Ventro-lateral view of the ovipositor and associated parts. 6. Sting glands and reservoir. 7. Section through spermatheca, spermathecal glands, and surrounding bodies. 8. Section of wall of lubricating gland. 9. Longitudinal section of poison glands, and reservoir with muscular coat. 10. Cross-section through poison duct and poison duct cells.


1st valvifer
9th tergite
vagina
lateral plates
2nd valvifer
3rd valvulae
bulb

5


sting gland
poison duct

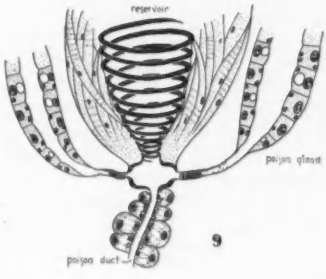
6


spermathecal gland
spermatheca
spermathecal duct

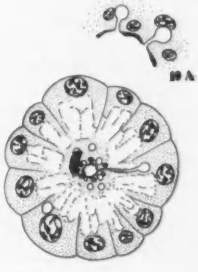
7

gland
lumen

8


reservoir
poison gland
poison duct

9



10 A

10

mon oviduct continuous with the vagina, which immediately makes a turn back on itself. At the proximal end of the vagina is given off the duct to the spermatheca and spermathecal glands, minute bodies usually lying closely between the posterior ganglion and the vagina itself.

Distal to the opening of the spermathecal duct the vagina makes another turn to enfold the ventral and lateral aspects of the bulb of the second valvulae. Thus the eggs descending the genital passages are directed into the bulb of the sting shaft. At the inside of the neck of this last bend is given off the median unpaired lubricating gland, a fairly large, sometimes lobular gland, attached by a short stout neck, and lying flat in the body cavity between the two second valvifers.

Large poison glands (fig. 6) are found in the posterior part of the abdomen, laterally displaced either to the right or to the left of the hind-intestine, and usually extending close to the dorsal wall. This unit of glands is composed of sometimes eight, sometimes ten elongate lobes, surrounding a central poison reservoir, or pump, and attached by thin stalks to the base of the reservoir. The length of the glands varies from one-half to twice the length of the reservoir. From the base of the reservoir runs quite a long poison duct that is surrounded by numerous large poison duct cells. The poison duct courses ventrad, then cephalad along the lubricating gland and finally dips down over the central arm of the bulb of the second valvulae into the bulb itself.

Spermatheca and Spermathecal Glands.—A rather diagrammatic representation of this whole unit is shown in fig. 7. The spermatheca is a spherical cuticularized capsule, surrounded by a single layer of regular epidermal cells. A bulb-like process projects from the capsule and leads into a short, roughened duct. In one sectioned preparation an extremely fine duct was observed running through the center of this bulb, but its connection with the capsule proper was indistinct. The duct then branches into the spermathecal duct, and the spermathecal glands. The spermathecal duct follows a slightly convoluted course to the vagina and is invested with an irregular layer of cells. The ducts of the spermathecal gland are two blind extensions appearing like the stout ends of Indian clubs. They have extremely thin linings, appear water-clear in section, and are surrounded by lobes of rather irregular cellular layers. The lobes stain quite darkly, and in them are visible peripherally located nuclei. In addition to these nuclei there are a few somewhat smaller ones scattered more closely around the bulbs of the gland ducts. The whole mass is surrounded by a thin membranous coat that appears continuous around the spermathecal capsule. Around the capsule and glands and closely adhering to them are packed several other bodies. These bodies contain material that stains with Delafield's haematoxylin, and also large globules that stain with Sudan III. The bodies are therefore considered fat cells or clusters of fat cells. In serial sections the bodies are highly vacuolated, and nuclei, as shown with the Feulgen technique, are seen in some of them.

Lubricating Gland.—I have called this gland the lubricating gland because of the similarity it bears to glands at comparable locations in a number of ichneumonids described by Pampel (1913). In

Habrobracon juglandis, the wall of this gland is composed of a single layer of cuboidal cells with nuclei of varying sizes in varying positions. Rounded vacuoles of different sizes are present in some of the cells. The cytoplasm is homogeneous and fairly granular. There appears to be a slightly roughened lining to the lumen of the gland (fig. 8). Due to the position of the mouth of the gland on the vagina near the base of the ovipositor the secretion of the gland probably aids in the passage of the egg down through the poison canal of the valvulae.

The Venom.—The venom with which the insect paralyzes its host is secreted both by the large poison glands and by the poison duct cells. If the chemical nature of these venoms is comparable to those in other Hymenoptera (e. g., the honey bee), one of these groups is the acid glands, the other the alkaline glands.

Poison Glands.—Each poison gland (fig. 9) is made up of a single layer of heavy cuboidal cells, surrounding a central lumen. Nuclei are of two distinct sizes. The larger ones are round to oval, and peripherally placed in the cells. Some smaller nuclei are visible between the larger ones at the periphery, while there are many small nuclei that form more or less of a layer at the lumen ends of the cells. Some cells in section show distinct rounded vacuoles, the larger ones causing the inner surfaces of the cells to bulge out into the gland lumen. The cytoplasm appears homogeneous and finely granular. The stalk of each gland possesses a delicate spiral lining and leads into a cuticular bulb at the base of the reservoir. Apparently the secretion from the cells passes into the lumen, down the stalk into the bulb, and up into the reservoir.

Reservoir.—The reservoir, or pump (figs. 6, 9), appears as a quite ovate body, pointed at either end, and lined with a very heavy cuticular spiral, medium brown in color, presenting a very striking appearance. In the literature I have found only two other forms, *Bracon nigropedator* and *Aphidius* sp., both braconids, that possess this type of poison reservoir; both these forms were described by Berlese (1909).

The reservoir is surrounded by a heavy muscular coat, made up of numerous striated muscle fibers that run longitudinally and are attached at numerous points along the spiral lining. From this arrangement of muscular fibers, we may deduce the mode of action of this pump. Apparently when the longitudinal muscles contract, the spiral reservoir is compressed, like a mattress spring, thus ejecting the poison down through the poison duct. Consequently, when the muscle fibers relax and the spiral springs back into shape, it probably sucks a fresh supply of poison from the gland lumens back up into the reservoir.

Poison Duct and Cells.—From the small duct at the base of the reservoir runs the poison duct, surrounded by its numerous cells. The wall of the duct is rather heavily sclerotized and appears quite roughened in texture (fig. 10). The surrounding cells are heavily vacuolated and possess definite oval nuclei at the periphery of the cells. The vacuoles are sponge-like in appearance and occupy the larger part of each cell. As a result, the cytoplasm, which is finely granular, exists largely in the area around the nuclei.

From the poison duct arise numerous small spherical processes, connected to the duct itself by extremely fine necks (fig. 10A) and extending directly into the proximal portions of the surrounding cells. In sectioned material, these processes appear water-clear. It is undoubtedly directly through these very thin-walled processes—extensions of the poison duct—that the poison duct cells can pour their secretions and add to the venom from the poison glands. In addition to the regular nuclei of the large gland cells are numerous small nuclei close to the duct lumen, interspersed among and sometimes seen to hug the little processes. These minute processes are extremely numerous at the reservoir end of the duct, decrease in number along the duct's course, until none at all exist as the duct approaches and enters the bulb of the second valvulae. Moreover, as the duct curves around into the bulb, the poison duct cells disappear.

DISCUSSION

The reproductive and associated organs of the honey bee have been the subject of the most careful investigations and are the best known of all the Hymenoptera (Bresslau, 1906; Adam, 1912; Snodgrass, 1925; v. Siebold, 1834; etc.). If we compare the organs of *Habrobracon* with those of the honey bee, certain striking similarities and differences are apparent.

In the honey bee there are numerous ovarioles composing the two large ovaries and possessing relatively small eggs, whereas in *Habrobracon* each ovary consists of but two ovarioles, each possessing a few relatively large eggs. Copulatory pouches, present in the honey bee, are absent in *Habrobracon*. A complicated muscular valve such as that which controls the dispersal of sperm from the spermatheca in the honey bee was not observed in *Habrobracon*. The bulb-like extension of the spermathecal capsule, however, suggests a valve.

In the honey bee there are two poison glands—the acid glands and the alkaline glands, both emptying separately into the bulb of the sting. The poison gland system of *Habrobracon* also has two distinct components: the poison glands themselves composed of 8 or 10 individual lobes surrounding the reservoir, and the poison duct cells that pour their secretions individually into the duct along its entire length.

Wilhelm Pampel has described the "Geschlechtsapparat" for many ichneumonids, and the main organs found in *Habrobracon* are present in one form or another among this group of Hymenoptera. The course which an egg must take in being laid by *Habrobracon*—that of being forced through the poison canal of the valvulae—is the same as that described by Pampel for the *Ophion*-like ichneumonids. The similarity between the poison reservoir in *Bracon nigropedator* and in *Aphidius* (as described by Berlese) and that in *Habrobracon* appear very close.

LITERATURE CITED

Adam, A. 1912. Bau und Mechanismus des Receptaculum seminis bei den Bienen, Wespen, und Ameisen. Zool. Jahrb., Abt. f. Anat. u. Ontogonie, 35, Heft I, pp. 1–74.

Berlese, A. 1909. Gli Insetti, Volume I. Chapter 13, Organi delle Reproduzione, pp. 891–892.

Bresslau, E. 1906. Der Samenblasengang der Bienenkönigen. Zool. Anz., 29: 299–323.

Ephrussi, B., and **Beadle, G. W.** 1936. A technique of transplantation for Drosophila. Amer. Nat., 70: 218–225.

Genieys, P. 1925. *Habrobracon brevicornis* (Wesmael). Ann. Ent. Soc. Amer., 18(2): 143–202.

Henschen, W. 1928. Über die Entwicklung der Geschlechtsdrüsen von *Habrobracon juglandis* Ash. Zeitschr. f. Wiss. Biol., Abt. A., pp. 144–178.

Pampel, W. 1913, 1914. Die weiblichen Geschlechtsorgane der Ichneumoniden. Zeitschr. f. Wiss. Zool., 108: 290–358.

v. Siebold, C. 1834. Über das Receptaculum seminis der Hymenopterenweibchen. Germer's Zeitschr. Entomol., Vol. 4.

Snodgrass, R. 1925. Anatomy and Physiology of the Honey Bee. McGraw-Hill, New York.

1933. Morphology of the Insect Abdomen, Part II. Smithsonian Miscellaneous Collections, Vol. 89, No. 8.

1935. Principles of Insect Morphology. McGraw-Hill, New York.

Speicher, B. R. 1931. The embryology of a parasitic wasp, *Habrobracon juglandis*. Unpublished Master's Thesis at the University of Pittsburgh.

Whiting, A. R. 1940. Sensitivity to X-rays of different meiotic stages in unlaid eggs of *Habrobracon*. Jour. Exp. Zool., 83(10): 250.

GENERAL CATALOGUE OF THE HEMIPTERA, W. E. China, General Editor, H. M. Parshley, Managing Editor; Fascicle IV, Fulgoroidea, Part 3, Araeopidae (Delphacidae), by Z. P. Metcalf, D.Sc., College of Agriculture and Engineering of the University of North Carolina. Published by Smith College, Northampton, Mass. 552 pp., $5.00.

This volume by Professor Metcalf constitutes an important addition to the series of catalogues of Hemiptera and consists of a brief introduction with characters of the families, biographical, historical resumé, geographical distribution and form of present catalogue. It includes references to 137 genera and 1,114 species, in closely printed matter and shows evidence of very careful determination of synonomy, bibliographical references and distribution. While verification throughout is impossible for the reviewer, many entries that have been noted particularly are certainly correct. Dr. Metcalf is certainly to be congratulated on the completion of this notable piece of time-consuming and exacting work.

—H. Osborn.

CLASSIFICATION OF THE DERMESTIDAE (LARDER, HIDE AND CARPET BEETLES) BASED ON LARVAL CHARACTERS, WITH A KEY TO THE NORTH AMERICAN GENERA, by Bryant E. Rees. U. S. Dept. of Agr. Miscellaneous Publication No. 511, 18 pp., 48 figs. 1943.

A paper based on material in the collection of the United States National Museum. Only very exactly identified larvae were used.—C. H. K.

THE ANOMALINI OF EASTERN NORTH AMERICA WITH DESCRIPTIONS OF THE LARVAE AND A KEY TO SPECIES (COLEOPTERA, SCARABAEIDAE), by P. O. Ritcher. Kentucky Agr. Exp. Station, University of Kentucky Bull. 442, 24 pp., 3 pls. (40 figs.). 1943.

A paper on larvae but which also gives good figures of the male genitalia of thirteen species the larvae of which are described and keyed out.—C. H. K.

A SYNOPSIS OF THE LIMULODIDAE (COLEOPTERA): A NEW FAMILY PROPOSED FOR MYRMECOPHILES OF THE SUBFAMILIES LIMULODINAE (PTILIIDAE) AND CEPHALOPLECTINAE (STAPHYLINIDAE)

CHARLES H. SEEVERS,
Central YMCA College, Chicago, Illinois
AND
HENRY S. DYBAS,
Field Museum of Natural History, Chicago, Illinois

The subfamily Cephaloplectinae of the Staphylinidae as now constituted is a very heterogenous group of genera; some of its members are not even staphylinids, and the others may well be assigned to other subfamilies. In 1883, Sharp described a very remarkable beetle, *Cephaloplectus godmani*, which had been collected from a Panamanian army-ant colony, and erroneously believing it to be a staphylinid, proposed the subfamily category to receive it. Subsequent investigators, especially Wasmann, perpetuated the error and increased the confusion immeasurably by assembling within the subfamily a number of unrelated beetles collected with army-ants and termites. The eight genera which have comprised the Cephaloplectinae resemble each other in only the most superficial characters and represent four rather widely divergent groups of beetles. One of these groups, including *Cephaloplectus* and related genera, should be removed from the Staphylinidae and the other groups should be reassigned to proper categories within that family. The investigations herein reported were initiated with the object of clearing up this situation as completely as possible with the material available. The problems proved to be more numerous than was first apparent, and instead of one paper, several will be necessary. The present paper is concerned with the removal of the non-staphylinid genera of the Cephaloplectinae and their combination with several genera of the Ptiliidae to form a new family. The remaining genera of the Cephaloplectinae will be reassigned in a later paper.

It has been evident to the writers from the inception of these studies that *Cephaloplectus* is closely related to the myrmecophilous genus *Limulodes* Matthews. This latter genus has from the time of its description in 1867 been classified with the Ptiliidae (=Trichopterygidae) to which it is undoubtedly related. The fact, however, that it occupies an isolated position with respect to that group was recognized by Ganglbauer (1899) who proposed the subfamily Limulodinae to indicate this. The writers have examined *Limulodes* and *Cephaloplectus* in detail, and believe that these two and a few related genera constitute a homogenous group which is sufficiently distinct from the Ptiliidae to be regarded as a separate family, the Limulodidae. In the morphological account which follows, it will be shown that these species are highly specialized for a myrmecophilous life and that the degree of specialization argues for long association with ants. The obligate myrmecophily resulting

from this association has served to bring about a distinctly isolated group; there are no known intermediate genera which would bridge the gap between the Limulodidae and the Ptiliidae. The contrast between *Cephaloplectus* (the most highly specialized of the group) and the Ptillidae is particularly noteworthy.

The principal aim of this paper is, therefore, to present as complete an account of the morphology and taxonomy of the Limulodidae as is feasible with material available. The initial step in eliminating the confusion concerning the status of the Cephaloplectinae is thereby completed. The remaining genera of the Cephaloplectinae have been or will be discussed elsewhere by the writers: *Termitopsenius* Wasmann was referred to the Trichopseniinae and *Callopsenius* Wasmann to the Aleocharinae in a previous paper (Seevers, 1941), and *Vatesus* Sharp and *Wasmannotherium* Bernhauer (= *Xenocephalus* Wasmann) will be considered in a subsequent one. It is, of course, obvious that the subfamily name Cephaloplectinae is superfluous and ceases to exist as a category in the Staphylinidae. Since it seems desirable to summarize the history of the Cephaloplectinae, the writers have done so in a separate section of the paper, where all additions to the group and their dispositions are noted.

While all of the species herein incorporated within the family were not available for study, it is believed that sufficient material was at hand to permit the establishment of a useful basis for future studies. Of the twenty-seven species included in the family, the writers have examined fourteen, eight of which are new. Only one (*Paralimulodes* Bruch) of the five genera was not seen. Although many of the descriptions of the species not available appear inadequate for their recognition, host and locality data may make determinations possible.

All of the Limulodidae are myrmecophilous, and although they have been found with ants of the five major subfamilies, it appears as if they occur most abundantly with army ants of the genus *Eciton*. Many of them are probably monoxenous but this does not seem to be universally true, for the available data indicate the occurrence of some species with several hosts. More data may reveal, however, that what appears to be one species of beetle living with several different ants, may represent several closely related species of beetles, each associated with a different ant. There is some evidence at hand to support such a view, but no attempt to utilize these data is made at this time since they are scarcely numerous enough to be clearly significant. The ecological relationships of the group are discussed at greater length in another section of the paper (p. 561).

The family is now known to be distributed from Massachusetts to Argentina in the new world and to occur in the Australian continent. Judging only from one species, the Australian genus *Rodwayia* seems to be comprised of rather generalized forms which are quite closely related to several of the United States species. The most highly specialized members of the family, those of the genus *Cephaloplectus*, occur in the neotropics.

For aid in connection with these investigations, the writers are indebted to Dr. Orlando Park for many important specimens, to Dr. R. E. Blackwelder and Dr. W. M. Mann for co-operation in making the

material in the United States National Museum available for study, to Dr. P. J. Darlington for specimens from the Museum of Comparative Zoology, to Dr. C. H. Curran for the American Museum of Natural History material, and to Drs. Neal Weber, M. R. Smith, and Robert Gregg for identifications of host ants.

HISTORICAL REVIEW OF THE SUBFAMILY CEPHALOPLECTINAE

As indicated in the introduction, it seems desirable to summarize the principal steps in the organization of the Cephaloplectinae and the reclassification of its genera as the subfamily is now dissolved. This should aid in preventing further confusion with respect to the group. The genera and species of the subfamily were catalogued by Eichelbaum (1909, p. 191), Bernhauer (1916, p. 443), and Scheerpeltz (1933, p. 1472).

1883. Sharp proposed the subfamily Cephaloplectinae to include the genus *Cephaloplectus* Sharp; one species, *C. godmani* Sharp, collected with army ants in Panama, was described.
1887. Wasmann proposed the subfamily Xenocephalini for the genus *Xenocephalus* Wasmann; one species, *X. clypeatus* Wasmann, collected with army ants in Brazil, was described.
1889. Wasmann included the genus *Vatesus* Sharp (1875) in the Xenocephalini; the one species, *V. latitans* Sharp, recorded from Brazil, had been classed with the Tachyporini.
1900. Wasmann regarded the name Xenocephalini as a synonym of Cephaloplectinae; this subfamily then included *Cephaloplectus*, *Xenocephalus*, *Vatesus* and a new genus *Exitoxenus* Wasmann. One species, *E. heyeri* Wasmann, collected with Brazilian army ants, was described.
1902. Wasmann assigned two new termitophilous genera, *Termitopsenius* Wasmann from Argentina and *Callopsenius* Wasmann (=*Eupsenius* Wasmann) from Paraguay, to the Cephaloplectinae.
1908. Wasmann referred *Ecitoxenus heyeri* to the genus *Limulodes* Matthews (Trichopterygidae).
1921. Bernhauer (Deut. Ent. Zeit., 1921, p. 77) proposed the name *Wasmannotherium* for *Xenocephalus* (preoccupied, Kaup, Pisces, 1858).
1926. Mann included the genus *Eulimulodes* Mann in the Cephaloplectinae; one species, *E. mexicanus* Mann, collected with *Eciton* in Mexico, was described.
1890–1932. Eight additional species of *Cephaloplectus* were described or given names by Wasmann (1925), Mann (1926), and Bruch (1926); fifteen additional species of *Wasmannotherium* were described by Wasmann (1890, 1894, 1900, 1908, 1925, 1929), Bernhauer (1917), Mann (1925, 1926) and Bruch (1932).
1941. Seevers transferred *Termitopsenius* Wasmann to the subfamily Trichopseniinae, and *Callopsenius* Wasmann to the subfamily Aleocharinae.

In the present paper, *Cephaloplectus* and *Eulimulodes* are removed from the Staphylinidae and grouped with *Limulodes* and several other ptiliid genera in the newly proposed family Limulodidae. The two remaining genera of the Cephaloplectinae, *Wasmannotherium* and *Vatesus*, which should probably be classed as Tachyporinae, will be considered in another paper.

LIMULODIDAE: MORPHOLOGICAL CONSIDERATIONS

General Features.—The habitus (figs. 1, 2, 4) of all of the limulodids is very similar and there is no difficulty in recognizing them. They are rather appropriately named, since their appearance is not unlike that

of a small horse-shoe crab. These beetles are apparently admirably adapted to withstand attack since they are compactly constructed and are equipped with many protective devices. Since they are all inhabitants of ant nests it is not unreasonable to suspect that these specializations protect them from their hosts to some degree or did so at an earlier stage in their evolution. It seems likely that the evolution of these characteristics was originally correlated with the evolution of myrmecophily, but there is reason to believe that the relationship between these beetles and their hosts has progressed to a point where protective devices are not so necessary. The observations of Park (1933), discussed in another section of the paper, indicate a more amicable relationship than is suggested by a review of the protective specializations. But whatever the actual situation may be, the series of protective modifications is very impressive, and few vulnerable areas are presented to the external environment. The most noteworthy of these adaptations are outlined in the following account:

(a) The wedge-shaped body is constructed with smooth, evenly round contours, the pronotum and elytra are broadly and strongly convex, and the abdomen is tapered. (b) The head is so deeply inserted in the prothorax that only a small area is presented anteriorly, and this surface, which is slightly convex, conforms to the broad arc formed by the pronotum apically. No openings are presented dorsally or anteriorly. (c) The antennae are partially or completely protected by withdrawal into deep fossae and by the presence of postgenal plates ventral to the antennal fossae. (d) The labrum, in repose, is contiguous with the anterior margin of the mentum, and covers the prementum, labial palpi, mandibles (in part), and the membranous parts (galea, lacinia) of the maxillae. (e) The overhanging pronotal and elytral margins protect the underparts. (f) The close relationship of prothorax and mesothorax virtually precludes movement between the two. This intimate association is brought about by the prolongation of the posterior pronotal angles to envelop the elytral humeri, which are ridged to interlock with the pronotal hypomera, by the carinate mesopleura which also interlock with the pronotal hypomera, and by the overlapping of the mesosternal carina by the large prosternal lobe. (g) The ankylosis of structures and the fusion of areas in the following situations: the inner elytral margins are interlocked so that their separation is difficult, the elytra are almost fused to the mesonotum, and the sternonotal, pleural and sterno-pleural sutures are absent. (h) The legs are afforded ample protection in various ways. The metathoracic legs are capable of complete retraction beneath huge metacoxal plates, and the tibia of the fore and middle legs may be partially withdrawn beneath laminations of the femora. The legs are frequently heavily armed. The side margins of pronotum and elytra aid in the protection of the legs. (i) The abdomen is capable of considerable retraction and may be drawn beneath the large elytra.

Head Capsule and Tentorium.—While the structure of the head is basically similar to that of the Ptiliidae, there are specializations, particularly in *Cephaloplectus*, that depart considerably from it. The head capsule and tentorium of *Limulodes* are figured by Stickney (1923, figs.

31, 177, 324, 469), in his comparative morphological study of the coleopterous head, to represent the Ptiliidae. Since the head structure of other Ptiliidae was neither figured nor discussed, the choice of a specialized beetle to represent the family was not well taken, even though the *Limulodes* head exhibits many characters in common with that of the ptiliids.

The head is inserted in the anterior foramen of the prothorax in such a manner that the "dorsum" of the head (vertex) is directed anteriorly. The "frontal" and "postclypeal" portions of the "dorsum" are deflexed and, because of the orientation of the head with respect to the thorax, occupy a ventral position. The terms vertex, front and postclypeus are used only relatively since the landmarks that determine these areas are absent or are of little value. The deflexed portion of the dorsum is not especially pronounced in *Limulodes* but is considerably so in *Cephaloplectus*, as the head seems to be somewhat inflated in that genus to extend for some distance cephalad.

The antennal fossae vary considerably from a moderate size in *Limulodes* to profound cavities in *Cephaloplectus*. In the latter genus they are so deep as to be almost contiguous at the center of the head. The breadth of the head is variable, depending on whether the head capsule anterior and ventral to the antennal fossae is produced laterally into lamellae (*Cephaloplectus* and *Eulimulodes*), or not (*Limulodes*). All of the genera possess a shelf-like triangular plate ventral to the antennal fossae, probably formed from the postgenae.

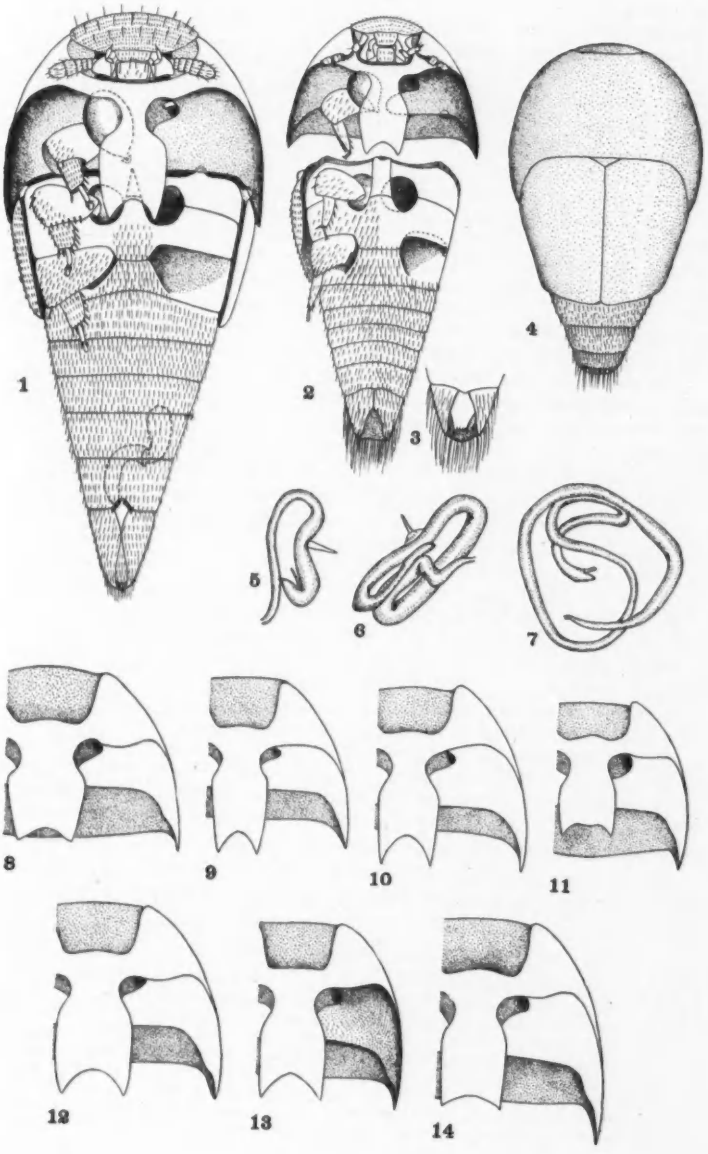
The condition of the tentorium (figs. 15–18) is that of the Ptiliidae in general. The posterior tentorinae occupy positions at the posterior margin of the head capsule. This is presumably a rather generalized position as they have not migrated cephalad to give rise to a gula. The posterior tentorial arms extend forward to the juncture of the dorsal and anterior arms. The dorsal arms are well developed in all of the genera, but they terminate short of a connection with the vertex. The anterior arms are variable in length, depending upon the depth of the antennal fossae. In *Limulodes* (fig. 17) they are moderately long, but in *Cephaloplectus* (fig. 15) they are extremely short since the anterior tentorial pits are located deep within the antennal fossae. The posterior arms are connected caudally by a transverse tentorial bar.

The principal trends in the evolution of the limulodid head as shown by a comparison of *Limulodes* and *Cephaloplectus* seem to be: (1) a departure from the dorso-ventrally compressed head, so typical of the Coleoptera, and the dilation and deflexion of the dorsum so that the strongly convex vertex, front, and postclypeus occupy anterior and

---

EXPLANATION OF PLATE I

Figure 1. *Cephaloplectus mus* Mann. Ventral aspect. 2. *Limulodes paradoxus* Matth. Ventral aspect, male. 3. *Limulodes paradoxus* Matth. Ventral aspect of apex of abdomen, female. 4. *Limulodes parki* n. sp. Dorsal aspect. 5. *Limulodes paradoxus* Matth. Spermatheca. 6. *Limulodes stenotropis* n. sp. Spermatheca. 7. *Cephaloplectus mus* Mann. Spermatheca. 8. *Limulodes parki* n. sp. Prothorax. 9. *Limulodes navajo* n. sp. Prothorax. 10. *Limulodes pallidus* n. sp. Prothorax. 11. *Limulodes brachyscelis* n. sp. Prothorax. 13. *Limulodes stenotropis* n. sp. Prothorax. 14. *Limulodes philovagans* n. sp. Prothorax.


1
2
3
4
5
6
7
8
9
10
11
12
13
14

ventral positions in front of the labrum, and (2) the extreme development of the antennal fossae. While the structures of the dorsal surface seem to have become highly specialized, those of the ventral surface appear to have remained relatively conservative. Although derived of ptilioid stock, presumably at some rather remote period, the ventral side of the head and the tentorium have remained essentially the same.

Antenna.—Ten segments characteristically compose the antenna, but this number has been reduced to eight or nine segments (Bruch does not state exactly) in *Paralimulodes*. Two antennal forms are present in the group, those exemplified by *Limulodes* and *Cephaloplectus*. The first type is illustrated by figures 23–30. The club-shaped scape, which is of moderate length, is usually concealed within the antennal fossa. The second segment partially conceals the third segment which is set in its apex. Segments 3–7 are small and apparently do not vary greatly, while segments 8–10 are enlarged to form a loose club. The terminal three segments are somewhat variable and have some taxonomic value.

The *Cephaloplectus* antenna (fig. 15), which is deeply inserted in the head, is composed of an extremely long, arcuate, cylindrical scape, a very long second segment, six moderately large, transverse, intermediate segments, a large, rectangular penultimate segment, and a smaller, rounded terminal segment. Segments 3–10 are compressed.

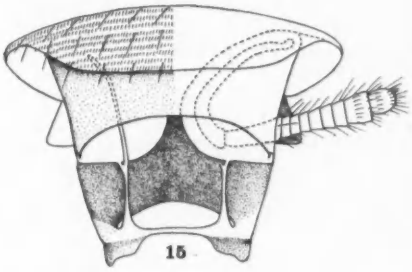
Eyes.—The writers have been unable to detect eyes in any of the species examined and are inclined to regard eyelessness as a family characteristic despite the reports of their presence by some observers. Stickney (1923) indicates a rather large eye on his outline drawings of the *Limulodes* head but is inconsistent in its location in different views. While we do not know which North American species of *Limulodes* was studied by Stickney (since his designation *L. paradoxus* may have been incorrect), it is unlikely that he had a species unknown to us. There is certainly no eye of the proportions figured by Stickney in any of the species at hand so we are inclined to believe that he was mistaken. It is very likely that the large antennal fossa, which is outlined through the head capsule in slide preparations, was interpreted as an eye by Stickney for this error is an easy one to make. Other references to be questioned for the same reason include: Wasmann's description of a small eye in *Limulodes heyeri* and Bruch's reference to the single-faceted eyes of *Paralimulodes* and the large, flat eyes of *Limulodes argentinus*.

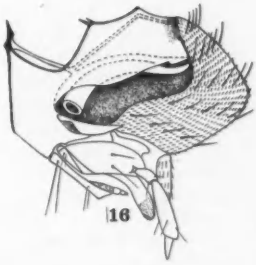
Mouthparts.—Because of the orientation of the head, the labrum is directed caudad in a horizontal plane and is so constructed that its apical

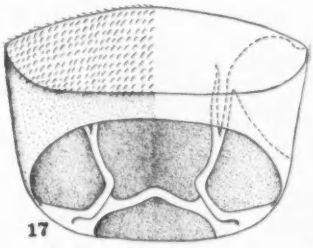
---

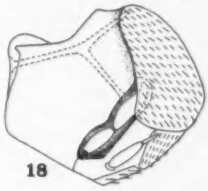
EXPLANATION OF PLATE II

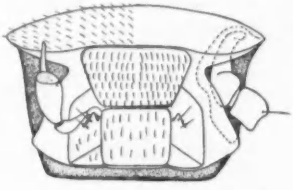
Figure 15. *Cephaloplectus mus* Mann. Dorsal view of head. 16. *Cephaloplectus mus* Mann. Lateral view of head. 17. *Limulodes parki* n. sp. Dorsal view of head. 18. *Limulodes parki* n. sp. Lateral view of head. 19. *Limulodes parki* n. sp. Ventral view of head. 20. *Cephaloplectus mus* Mann. Maxilla. 21. *Cephaloplectus mus* Mann. Mandible. 22. *Cephaloplectus mus* Mann. Labium. 23. *Limulodes paradoxus* Matth. Antenna. 24. *Limulodes parki* n. sp. Antenna. 25. *Limulodes navajo* n. sp. Antenna. 26. *Limulodes pallidus* n. sp. Antenna. 27. *Limulodes stenotropis* n. sp. Antenna. 28. *Limulodes manni* n. sp. Antenna. 29. *Limulodes brachyscelis* n. sp. Antenna. 30. *Limulodes philovagans* n. sp. Antenna.


15

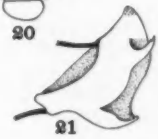

16


17

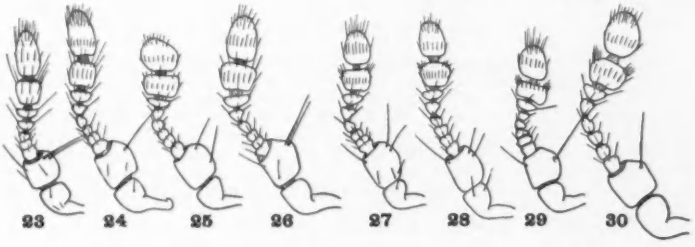

18


19

20


21

22


23 24 25 26 27 28 29 30

margin closely approximates the cephalic margin of the mentum, and thus covers the mouth as well as the more delicate parts of the labium and maxillae. The only apparent modification within the group is in its proportions; it is, for example, considerably broader and more trapezoidal in *Cephaloplectus*.

The small mandibles (*Cephaloplectus*, fig. 21) are almost entirely concealed by the labium and maxillae. The medial margin of the mandible is straight and the molar surface is greatly reduced. The outer margin bears two large teeth; the basal tooth is broader and stouter than the subapical one which bears a denticle near its apex. The narrow, feebly rounded apex of the mandible is beset with a variable number of minute denticles.

The maxilla of *Cephaloplectus* is illustrated by fig. 20. The galea is moderately broad and rather long and its rounded apex, which is directed medially, bears a series of longitudinal rows of short setae. The lacinia is shorter than the galea and more slender, and its incurved apex is incised to form a terminal tooth and a subapical one; it may or may not bear a terminal tuft of setae. The maxillary palpus articulates submarginally and subapically with the stipes. The four-segmented maxillary palpus consists of a small basal segment, moderately large intermediate segments and an aciculate terminal segment. The form of the second and third segments varies intergenerically.

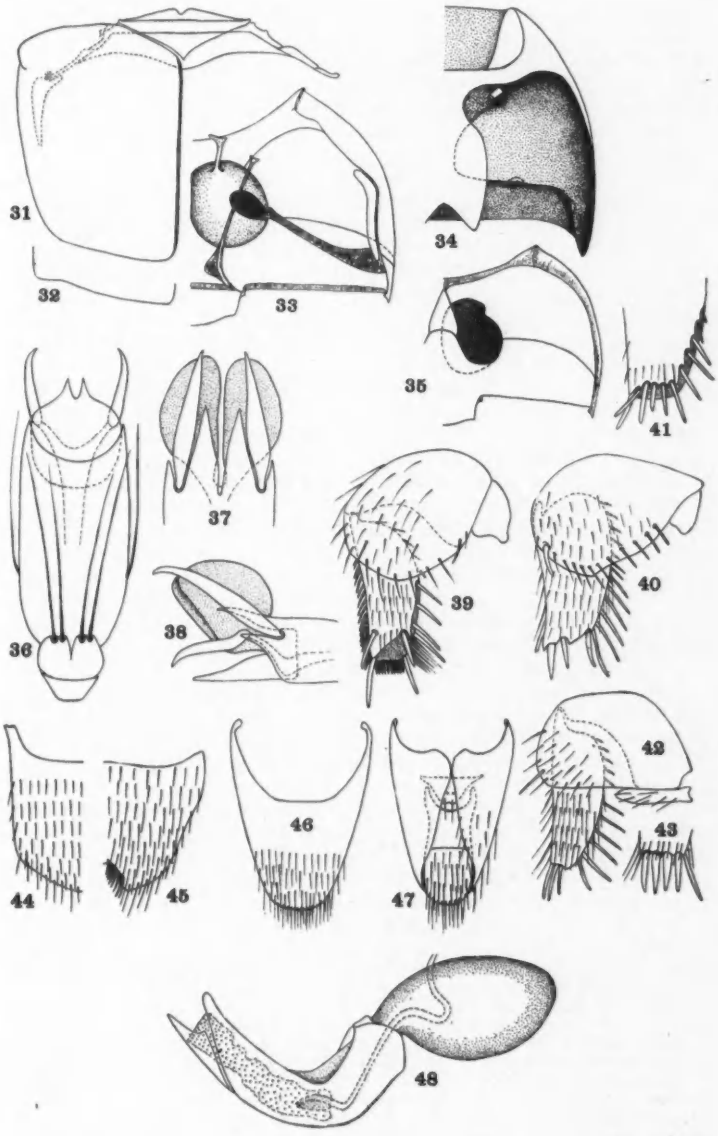
The labium (*Cephaloplectus*, fig. 22) is composed of a large sclerite (probably the mentum) and the prementum. The parts of the prementum are difficult to interpret. In *Cephaloplectus* there is a median triangular membranous area (the glossae ?), a lateral lobe (paraglossa ?) on each side dorsal to the palpi, and a process, which bears terminal setae, articulating at the juncture of the above structures. Lateral and slightly dorsal to the paraglossa, there is a process bearing a medial row of spines; possibly this is the hypopharynx. The basal segment of the three-segmented labial palpus is cylindrical, the second segment broader and longer, and the third segment is more slender and somewhat ovoidal.

Thorax.—The pronotum, which is very similar in all of the genera, is strongly convex. The side margins converge strongly in front and form, with the front margin of the deeply inserted head, an evenly rounded anterior margin of the beetle. The posterior angles of the pronotum are prolonged and closely applied to the elytral humeri (figs. 1, 4). The

---

EXPLANATION OF PLATE III

Figure 31. *Cephaloplectus mus* Mann. Mesonotum and elytron. 32. *Cephaloplectus trilobitoides* Mann. Apex of elytron. 33–48. *Cephaloplectus mus* Mann. 33. Dorsal view of mesosternum, mesopleuron, metasternum, and metapleuron. 34. Prothorax, ventral view. 35. Ventral view of mesothorax and metathorax. 36. Ventral view of prothoracic tarsus. 37. Dorsal view of prothoracic tarsus (terminal segment). 38. Lateral view of prothoracic tarsus (terminal segment). 39. Prothoracic leg, anterior surface. 40. Mesothoracic leg, anterior surface. 41. Apex of mesothoracic tibia, posterior surface. 42. Metathoracic leg, anterior surface. 43. Apex of metathoracic tibia, posterior surface. 44. Eighth tergite, male. 45. Eighth sternite, male. 46. Ninth (?) abdominal segment, male, dorsal view. 47. Ninth (?) abdominal segment, male, ventral view. 48. Aedeagus.


31
32
33
34
35
41
37
36
38
39
40
44
45
46
47
42
43
48

inflexed portion of the pronotum (hypomeron) is very extensive. The hypomera (figs. 8–14, 34) are united to the prosternum (sterno-notal sutures absent) anterior to the coxae, while caudally they are strongly deflexed against the pronotum and extend medially almost to the midline. Along the free caudal margin of each hypomeron there are two grooves into which mesothoracic carinae interlock; the medial one receives a carina of the mesopleuron, and the lateral one the elytral humeri.

The prosternum consists of a transverse bar in front of the coxae and a large prosternal lobe. The latter is narrow between the coxae and then expands to form a large plate which covers the mesosternum and a portion of the metasternum. The apex of the prosternal lobe is emarginate. The prothorax of the Limulodidae is somewhat specialized, yet during the speciation within the family it has remained remarkably uniform in structure. The very conspicuous changes which marked the evolution of the *Cephaloplectus* head were not accompanied by important modifications of the thorax.

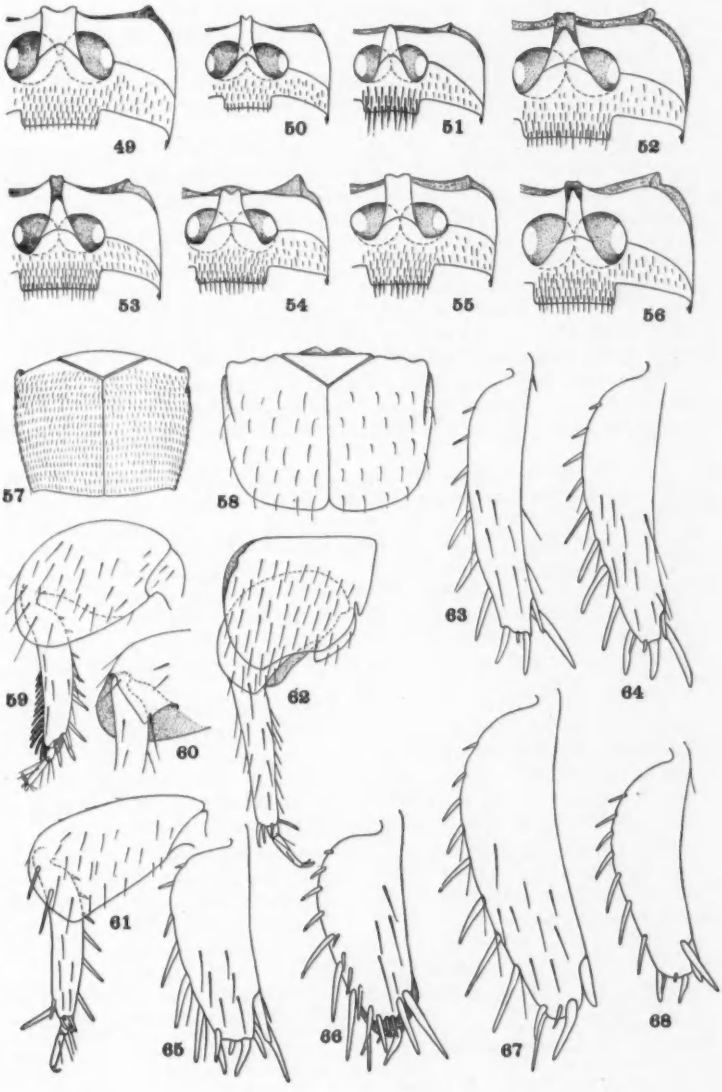
The sternal and pleural regions of the mesothorax are not clearly differentiated. The lateral limit of the mesosternum (figs. 35, 49–56) is not demarcated since the sterno-pleural sutures usually separating it from the mesepisterna are absent. In addition, the pleural region is not divided by the pleural sutures into an episternum and epimeron and so will be referred to as the mesopleuron. The mesosternum is more or less elevated medially to form a carina of variable proportions; this is in some instances slightly produced apically. The mesopleuron is sharply margined at the anterior and lateral borders of the ventral surface since it is bent abruptly dorsad to form the anterior and lateral faces of the mesothorax. The mesopleuron is also carried on to the dorsal surface to some extent. The anterior face of the mesopleuron bears a vertical carina which interlocks with the pronotal hypomeron.

The mesocoxal cavities are enclosed internally by large capsules (figs. 33, 35) formed apparently in part by the mesosternum and in part by the metasternum; the contribution of each is difficult to determine. The mesocoxal capsules are contiguous in some instances and are somewhat separated in others.

The metasternum extends forward between the coxae on the ventral surface to meet the mesosternum. Caudally the metasternum is produced between the hind coxae to form a rather broad process which to a slight degree overlies the third abdominal sternite. The metasternum is

EXPLANATION OF PLATE IV

Figure 49. *Limulodes parki* n. sp. Ventral view of mesothorax and metathorax. 50. *Limulodes navajo* n. sp. Same. 51. *Limulodes pallidus* n. sp. Same. 52. *Limulodes bolivianus* n. sp. Same. 53. *Limulodes stenotropis* n. sp. Same. 54. *Limulodes brachyscelis* n. sp. Same. 55. *Limulodes philovagans* n. sp. Same. 56. *Limulodes manni* n. sp. Same. 57. *Limulodes navajo* n. sp. Elytra, scutellum. 58. *Limulodes pallidus* n. sp. Same. 59–63. *Limulodes paradoxus* Matth. 59. Prothoracic leg, anterior surface. 60. Prothoracic femur and tibia, posterior surface. 61. Mesothoracic leg, anterior surface. 62. Metathoracic leg, anterior surface. 63. Mesothoracic tibia. 64. *Limulodes parki* n. sp. Mesothoracic tibia. 65. *Limulodes brachyscelis* n. sp. Mesothoracic tibia, anterior surface. 66. Same, posterior surface. 67. *Limulodes philovagans* n. sp. Mesothoracic tibia, anterior surface. 68. *Limulodes navajo* n. sp. Same.


49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68

separated from the mesopleuron lateral to the middle coxae by a suture which extends from the coxal cavity to the lateral margin.

The divisions of the mesonotum ("scutellum") are not easy to determine and no attempt will be made to distinguish prescutum, scutum and scutellum. In addition to the raised triangular area visible externally, there are rather extensive lateral processes (fig. 31) which taper to slender arms for some distance beneath the elytra and articulate with them.

The elytra are intimately articulated with the mesonotum and are in most instances difficult to separate from it. The elytron articulates with a small condyle of the mesonotum near the elytral base and with a knob at the apex of the lateral arm of the mesonotum which fits in an acetabulum on the ventral face of the elytron medial to the humerus. The elytron also bears a small condyle near its inner basal angles which articulates with the mesonotum. The elytra are incapable of being moved and the articulating surfaces mentioned approach ankylosis in many instances. Furthermore, the elytra are intergrooved along the median line to prevent movement. The elytral humeri are produced as short carinae (figs. 1, 2, 57) which interlock with the pronotal hypomera; the carinae are transversely striated in some instances. The elytral epipleurae are moderately large and are almost appressed against the elytra.

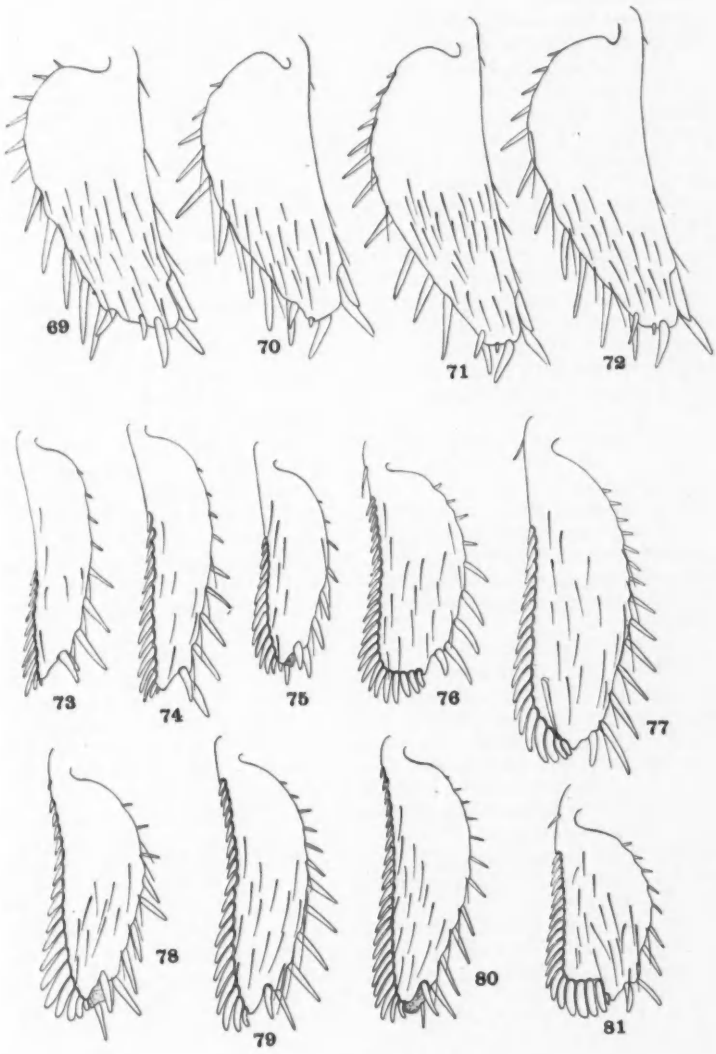
The metapleural elements (fig. 33) are apparently represented by a short metepisternum, which gives rise at its caudal end to the condyles for the lateral articulation of the hind coxa, and a metepimeron. The metepimeron (figs. 31, 33) is closely associated at its anterior end with the lateral arm of the mesonotum mentioned above, in fact, it is so closely applied to the mesonotum that it is invariably removed with the elytra and mesonotum when they are dissected from the body. The position of the metepimeron in these cases is such as to mislead one into interpreting it as a vestige of a wing, unless care is taken in noting its relationships.

The writers have been unable to detect any structures which may be interpreted as metanotum or any vestiges of wings. The absence of wings and the non-sclerotized metanotum are apparently the result of long association with ants. There are references in literature to the existence of vestigial wings in *Limulodes* but we are of the opinion that these have resulted from misinterpretation of the metepimeron.

The Legs.—The legs seem to be the most variable structures of the body and offer the best taxonomic characters. The following generalizations are supplemented by detailed considerations in connection with species diagnoses.

EXPLANATION OF PLATE V

Figure 69. *Limulodes pallidus* n. sp. Mesothoracic tibia, anterior surface. 70. *Limulodes stenotropis* n. sp. Same. 71. *Limulodes manni* n. sp. Same. 72. *Limulodes bolivianus* n. sp. Same. 73. *Limulodes paradoxus* Matth. Prothoracic tibia, anterior surface. 74. *Limulodes parki* n. sp. Same. 75. *Limulodes navajo* n. sp. Same. 76. *Limulodes pallidus* n. sp. Same. 77. *Limulodes philovagans* n. sp. Same. 78. *Limulodes stenotropis* n. sp. Same. 79. *Limulodes manni* n. sp. Same. 80. *Limulodes bolivianus* n. sp. Same. 81. *Limulodes brachyscelis* n. sp. Same.


69
70
71
72
73
74
75
76
77
78
79
80
81

The anterior coxae (figs. 1, 2) are large and ovoidal; anteriorly they articulate with moderately long, rod-like trochantins which extend into the coxal cavity from beneath the hypomera; caudally each coxa is drawn out into a short process which rotates in an acetabulum on the dorsal surface of the prosternal lobe.

The globose mesothoracic coxae (figs. 1, 2) are set in coxal capsules which possess lateral foramina for the coxal articulation with the coxal process of an apophysis (fig. 33) near the posterior border of the mesopleuron.

The metathoracic coxae (figs. 1, 2, 62) are very large and platelike; they articulate medially with a metasternal condyle and laterally with a process of the metepisternum. The coxa completely conceals the hind femur and the entire metathoracic leg may be retracted beneath it.

The femora (figs. 39–42, 59–62) are usually broad and compressed and are expanded apically into laminae to partly conceal the tibiae; they may be bilaminate or unilaminate. The femora are frequently armed with spines and setae. The tibiae are also compressed; they are variable in shape and offer good taxonomic characters. The tibiae are usually heavily armed with spines, but *Paralimulodes* possesses spineless tibiae and *Rodwayia* seems to have but few. The prothoracic tibiae characteristically bear combs of spines along the lateral and apical borders. The anterior tibiae of the males have a dense tuft of hairs on the medial border near the apex.

The tarsi are composed of three tarsomeres; the basal segment is extremely small and is set deeply within the apex of the tibia; the second segment is also rather small but is clearly visible, and the third segment is usually quite long. All previous descriptions of the *Limulodes* tarsus have stated that they are two-segmented but in view of the minuteness and position of the basal segment, this is easily understandable.

The tarsus of *Cephaloplectus* (fig. 36–38) is somewhat more specialized than that of the other genera. The second segment is incised medially and appears bilobed; each lobe bears two very long and stout setae which extend along the plantar surface almost to the apex of the terminal segment. The third segment is elongated and bears a rather complex pretarsus. The apex of the upper surface (fig. 37) of the third segment is deeply incised medially to form two strong triangular processes. The ungues of the pretarsus articulate with the dorsal surface lateral to these processes. The side of the terminal segment (fig. 38) is drawn out into a spine ventral to the ungues. In addition to the ungues mentioned above, the pretarsus consists of a ventral unguitractor plate (fig. 36), a lateral pair of ventrally directed claw-like processes, and a pair of large, somewhat membranous, lamellae. The unguitractor plate, which is set in the end of the tarsus ventrally, is incised at the apex. The large leaf-like lobes are probably derivatives of the arolium but the origin of the lateral claws is somewhat difficult to determine. The tendon of the retractor muscles which extends to the pretarsus inserts, apparently, on the unguitractor plate, and then divides to extend on to the lateral claws upon which it also inserts.

Abdomen and Genitalia.—The abdomen, which is very contractile, tapers strongly to a narrow, rounded apex. The venter is rather convex; the dorsum is less so. The first two tergites are present beneath the elytra; the first is very feebly sclerotized. The sternites and tergites of segments 3–7 are generalized in structure, with the exception of the third sternite (figs. 1, 2) which is deeply depressed on each side to receive the metathoracic legs. Segments 3–7 bear a single paratergite on each side; these sclerites overlap the tergites somewhat. The eighth sternite and tergite are longer than the previous ones; the eighth male sternite may be incised medially and in some species of *Cephaloplectus* this incision may be bordered by combs of spines (fig. 45).

The sclerites of the ninth and tenth segments, which are difficult to homologize, are as follows: the apparent ninth tergite (figs. 46, 47) forms a tubular structure as its sides are extended ventrad and then mesad to the mid-line. Within this tubular sclerite on the ventral side, there is one sclerite in *Limulodes* and two in *Cephaloplectus* (fig. 47). The smaller, triangular, proximal sclerite in the male of *Cephaloplectus* is almost concealed within the tube while the larger, distal one, with its broadly rounded apex, protrudes from the tube ventrally. In the female of *Cephaloplectus*, these two sclerites are subequal in length.

The aedeagus of the male, as seen in *Cephaloplectus*, consists of a large proximal sac (fig. 48), which is very feebly sclerotized, and a distal, strongly sclerotized tube. The distal tube, which is sharply curved near the middle, seems to consist of one piece except for a separate flap-like apical sclerite which is hinged by a membranous area to the body of the tube. The ejaculatory duct enters the basal bulb, passes into the tube and terminates in an intromittent organ, the structure of which was not determined. This intromittent organ rests at the base of an extensive eversible sac which is beset throughout with minute denticles.

The spermatheca of *Limulodes paradoxus* is a slender U-shaped tube as illustrated by figure 5. Modification of this tube within the family is manifested by more extensive coiling; an intermediate condition is illustrated by *Limulodes stenotropis* (fig. 6) and the extreme situation by *Cephaloplectus* (fig. 7). Each of these spermathecae bears a lateral, appendiculiform process; this is probably a glandular sac.

ECOLOGICAL CONSIDERATIONS

The only recorded observations concerning the behavior of *Limulodes* are those of Park (1933) who studied the activities of *parki* n. sp. (then identified as *paradoxus* Matthews) in laboratory colonies of *Aphaenogaster fulva aquia* Emery. The most noteworthy observations made at that time are summarized briefly in the following account.

Limulodes was observed most frequently in the immediate vicinity of the host brood; some individuals were on the larvae when the colony was exposed in the field, and most of them constantly attended the larvae in the laboratory. They were noted to walk or run rapidly about among the ants, to cling to the larvae and pupae even when they were transported by the workers, and to ride the ants themselves. The riding of the workers by these beetles was noted on a number of occasions,

particularly when the larvae and pupae were removed from the observation colony. This riding was accompanied by feeding on the part of the beetles in many cases. The food of the beetles was obtained by scraping oils and other materials from the integument of the larvae, pupae and even the workers. In doing so, the beetles were engaged in the same way as the ants themselves, for they are constantly licking and scraping the brood and one another. Thus the beetles apparently take advantage of the exudations which form an essential part in the maintenance of the social organization. Park described the feeding behavior in some detail, noting the use of the setose galeae as excellently adapted combs for brushing integumental exudates from the hosts, and the laciniae and mandibles as aids in conveying materials to the mouth. He accredits the greatest role in feeding to the mandibles. The reaction on the part of the ants to the presence of the beetles was one of almost complete indifference, and only on a few occasions were the ants observed to attempt to dislodge beetles from their bodies or, in one case, to attempt to bite a beetle. Park concluded his studies with the belief that *Limulodes* is an obligatory synoekete which feeds on exudations of the host, and is not carnivorous nor a scavenger on nest refuse.

It will be noted from the list of records concluding this section of the paper that thirteen genera of ants are known to act as hosts to these beetles. These genera represent widely different groups of ants since the five principal subfamilies of ants are included. It is probably significant that the more generalized members of the Limulodidae occur with the greatest number of ant genera. As a matter of fact, only a relatively few species of the family occur with other than army ants; these are all members of *Limulodes* and *Rodwayia*. The family seems to have reached its greatest development in the American tropics where the more specialized members are all guests of *Eciton*.

Although the data pertaining to host relationships are inadequate, it seems that some of the species of beetles may occur regularly with several hosts (polyxenous) while others are apparently monoxenous. In no instance are the records sufficient in number to prove conclusive. Seven species have been recorded with more than one ant: four with two species of ants (of the same genus) and three with more than two species of ants (of several genera). There is evidence at hand to indicate that what we now regard as one species of *Limulodes* may prove to be more than one, so that some of these species are probably monoxenous. This is particularly true of *L. paradoxus*, in which case populations from different host species differ in characters which will probably serve to distinguish them as species. We refrain from making these specific distinctions at the present time since our data are scarcely large enough to carry sufficient weight. *L. parki* n. sp., as now defined, may also prove to be a complex of species, but this decision must also await more material. In this situation, however, the populations are exceedingly close, and it is rather interesting that such closely allied forms occur with four genera of ants, *Aphaenogaster*, *Formica*, *Pheidole*, and *Leptothorax*.

HOST RECORDS

Genus *Lasius* (Formicinae)

L. umbratus mixtus var. *aphidicola* Walsh.....*Limulodes paradoxus* Matth.—U. S.
L. (*Acanthomyops*) *claviger* Rog...*Limulodes paradoxus* Matth.—U. S.

Genus *Formica* (Formicinae)

F. rufibarbis var. *gnava* Buck.....*Limulodes parki* n. sp.—U. S.
F. sp., *rufa* group.....*Limulodes parki* n. sp.—U. S.

Genus *Aphaenogaster* (Myrmicinae)

A. fulva aquia Buckley.....*Limulodes parki* n. sp.—U. S.

Genus *Pheidole* (Myrmicinae)

P. dentata Mayr.....*Limulodes parki* n. sp.—U. S.
P. triconstricta var. *ambulans* Emery.....*Limulodes argentinus* Bruch—Argentina.

Genus *Leptothorax* (Myrmicinae)

L. curvispinosus Mayr.....*Limulodes parki* n. sp.—U. S.

Genus *Acromyrmex* (Myrmicinae, tribe Attini)

A. lundi Guérin.....*Limulodes elongatus* Bruch—Argentina.
A. (*Moellerius*) *heyeri* Forel.....*Limulodes elongatus* Bruch—Argentina.

Genus *Eciton* (Dorylinae)

E. (*E.*) *burchelli* Westwood.....*Limulodes brachyscelis* n. sp.—Panama.
Cephaloplectus mus Mann—Panama.
E. (*E.*) *vagans* Olivier.....*Limulodes philovagans* n. sp.—Ecuador.
Cephaloplectus mus Mann—Ecuador.
E. (*Labidus*) *coecum* Latreille.....*Limulodes bolivianus* n. sp.—Bolivia.
Limulodes heyeri Wasmann—Brazil.
Cephaloplectus trilobitoides Mann—Guatemala.
E. (*Labidus*) *praedator* F. Smith..*Cephaloplectus flavus* Mann—Costa Rica.
E. (*Acamatus*) *hetschkoi* Mayr.....*Cephaloplectus argentinus* Bruch—Argentina.
E. dulcius jujuyense.....*Cephaloplectus argentinus* Bruch—Argentina.
Limulodes tibialis Bruch—Argentina.
E. (*Acamatus*) *spegazzinii* Emery..*Paralimulodes wasmanni* Bruch—Argentina.
E. (*Neivamyrmex*) *wheeleri* Emery.....*Eulimulodes mexicanus* Mann—Mexico.
E. (*Acamatus*) sp.....*Limulodes pallidus* n. sp.—Mexico.
E. sp.....*Cephaloplectus godmani* Sharp—Panama.

Genus *Cheliomyrmex* (Dorylinae)

C. nortoni Mayr.....*Limulodes mexicanus* Silvestri—Mexico.

Genus *Camponotus* (Formicinae)

C. nigriceps.....*Rodwayia orientalis* Lea—Australia.
C. aeneopilosus.....*Rodwayia orientalis* Lea—Australia.
C. novae-hollandiae.....*Rodwayia orientalis* Lea—Australia.

Genus *Polyrhachis* (Formicinae)

P. ammon.....*Rodwayia orientalis* Lea—Australia.
P. sp.....*Rodwayia minuta* Lea—Australia.

Genus *Iridiomyrmex* (Dolichoderinae)

I. sp.....*Rodwayia orientalis* Lea—Australia.
I. sp.....*Rodwayia minuta* Lea—Australia.

Genus *Ectatomma* (Ponerinae)

E. metallicum.....*Rodwayia orientalis* Lea—Australia.
Rodwayia minuta Lea—Australia.

Genus *Amblyopone* (or near thereto) (Ponerinae)

A. sp.....*Rodwayia intercoxalis* Lea.

Genus unknown

Limulodes navajo n. sp.—U. S.
Limulodes stenotropis n. sp.—Costa Rica.
Limulodes manni n. sp.—Costa Rica.

ORDER **COLEOPTERA**

LIMULODIDAE NEW FAMILY

Limulodinae: subfamily of Trichopterygidae, Ganglbauer, 1899, Käfer v. Mitteleuropa 3, p. 297.
Limulodinae, Csiki, 1911, Coleopt. cat. 32, p. 55 (catalogue).
Cephaloplectinae (in part): subfamily of Staphylinidae, Sharp, 1883, Biol. Cent. Amer. 1 (2), p. 295.

Small, myrmecophilous beetles possessing a limuloid form; broadly rounded anteriorly, broadest near base of pronotum, abdomen tapered. Head deeply inserted in the prothorax, scarcely visible from above, conforming to the rounded contour of pronotum. Brachelytrous and apterous.

Head capsule so modified that definite sclerites are not distinguishable; head capsule strongly inflated anterior to the labrum in some genera. Labrum, in repose, directed caudad, almost horizontal in position and contiguous with mentum, thus covering and protecting many of the mouthparts.

Antennae ten-segmented (except in *Paralimulodes*), inserted in antennal fossae which may be extremely cavernous in some genera. Two general antennal forms are typified by *Limulodes* (figs. 23–30) and *Cephaloplectus* (fig. 15).

Gula absent, the postgenae united caudal to the mentum. Postgenae produced to form a shelf-like plate ventral to the antennal fossae. Tentorium composed of two long posterior arms connected by a transverse bar at the level of the posterior tentorial pits, two short anterior arms (extremely short in *Cephaloplectus*), and two rather long dorsal arms.

Eyes absent in all species observed; reports of eyes by some investigators have never been authenticated.

Mandibles very small, molar surface greatly reduced, outer margin bearing several teeth. Labium comprised of a rectangular mentum and a membranous prementum bearing a three-segmented palpus.

Maxilla composed of the lobose galea which bears rows of short setae and the slender lacinia with its toothed apex. The four-segmented maxillary palpus articulates sub-apically with the stipes.

Pronotum strongly convex, overlapping the base of the elytra, its produced posterior angles interlocking with the elytral humeri. Prosternum comprised of a transverse bar anterior to coxae and a large prosternal lobe which is directed caudally to overlie the mesosternum. Sterno-notal suture absent, the prosternum united to pronotal hypomera in front of coxae. The lateral and dorsal sides of the prothoracic coxal cavities formed by extensive hypomera. Anterior coxae ovoidal, posteriorly produced into a nipple which rotates in an acetabulum on the dorsal face of the prosternal lobe.

Mesosternum elevated at middle into a carina of variable form. Mesosternum and mesopleuron fused (sterno-pleural suture absent), mesopleuron not separable into mesepisternum and mesepimeron (pleural suture absent). Mesopleuron carinated to interlock with pronotal hypomeron. Mesothoracic coxae set in coxal capsules derived from both mesosternum and metasternum.

Mesothoracic scutellum produced laterally as long arms which articulate with acetabula on the ventral surfaces of the elytra. Elytra short, interlocked at median line and almost ankylosed with scutellum; epipleurae moderately large.

Wings absent and the metanotum entirely unsclerotized; no vestiges of these structures could be noted in any instance.

Metasternum produced and elevated between the middle coxae to meet the mesosternum and posteriorly between the hind coxae. Metepimeron articulating with the lateral arm of the mesonotal scutellum. Metepisternum short, slender. Metathoracic coxae large and platelike, almost concealing the metathoracic legs.

Femora compressed, laminated distally to partially cover tibiae. Tibiae compressed, subject to considerable variation in size and form, the front and middle tibiae usually rather heavily armed. Tarsi three-segmented; basal segment extremely small and concealed within the apex of the tibia. Pretarsus rather specialized in some genera.

Abdomen tapering to narrow apex, quite contractile. Sternite of the third segment deeply depressed laterally to receive the legs. Segments 3–7 with one paratergite on each side. Eighth sternite subject to modification in the male. Ninth tergite (?) produced ventrad to form a cylindrical tube (open on the ventral side) about the terminal part of the abdomen; within this tube are one or two ventral sclerites. Aedeagus comprised of a proximal bulbous portion and a more slender tubular distal part. Spermatheca tubular, varying from a simple U-shape to a much coiled form, and possessing a small tubular evagination at a variable distance from the apex.

Type Genus of the Family.—Limulodes Matthews.

Comparison of Limulodidae and Ptiliidae.—There is no doubt of the ptiliid affinities of the beetles under consideration. One needs to do no more than compare the structure of the head capsule and mouthparts in order to have the relationship clearly established. But in spite of this basic similarity, it is evident after detailed study that the limulodids have been isolated for a long period of time, and that they have become quite specialized for a myrmecophilous life. This long isolation has resulted in the assemblage of a complex of characters that distinctly differentiates this group from any of the ptiliids. It is this pronounced evolutionary trend away from the ptiliids that justifies, in our opinion, the separation of the group as a family.

The following limulodid characteristics are seldom or never encountered among the Ptiliidae: the large prosternal lobe, ten-segmented antennae, voluminous antennal fossae, eyelessness, aptery, the non-sclerotized metanotum, mesonotal arms articulating with the elytra, interlocking of elytral humeri and pronotum, spermathecal form, distinctive terminal abdominal segments, habitus and specializations for protection, obligate myrmecophily. It is obvious, of course, that some of these characters may appear from time to time among the ptiliids, but nowhere in that group do we find species that resemble the limulodids in having this set of characteristics. It is the entire complex of characters to which we direct attention, and these sharply demarcate the Limulodidae.

The conspicuous prosternal lobe is the most distinctive single characteristic of the family. None of the Ptiliidae possesses a prosternal lobe at all similar to it. Within the Limulodidae the lobe has been remarkably constant, for even *Cephaloplectus*, which has deviated considerably from *Limulodes* in some respects, shows no appreciable modification of this character.

The ten-segmented antennae differ from the typical ptiliid antennae not only in the reduced number of segments but also in general structure. However, the ptiliid antennae are somewhat variable in structure, so it is questionable to what extent a comparison may be made in this respect. The compressed antennae of *Limulodes*, and especially those of *Cephaloplectus*, are departures from the verticillate type so commonly noted among ptiliids.

The suggestion of antennal fossae may be noted in some ptiliids, but it is, indeed, only slightly suggestive of those encountered in this group. Among the Limulodidae, there is a progressive increase in the size of the fossae until in *Cephaloplectus* a situation is presented which is scarcely paralleled among the beetles; the head is so deeply impressed that the antennal fossae virtually meet in the center of the head.

The loss of eyes and wings is undoubtedly an accompaniment of the specialized mode of life of these beetles. Degenerative evolution is rather commonly noted in many groups of specialized insects and there are blind and wingless members of many families of beetles. In the Limulodidae, these losses apparently occurred early in the evolution of the group and they have become family characteristics. It appears that the evolution of aptery occurred early, since accompanying this change there has been the loss of the metanotal elements, and the locking of the elytra by the base and posterior angles of the pronotum.

The habitus of these beetles is of minor importance in distinguishing them from the Ptiliidae, but is, nevertheless, distinctive. The same may be said for a series of minor modifications which seem to have had adaptive significance in connection with myrmecophily. The sum total of these "protective" devices is quite impressive and distinctive; they are discussed in the morphological section of the paper.

The fact that the Limulodidae are obligate myrmecophiles is important in contrasting them with the Ptiliidae, for the members of the latter group are primarily fungus-spore feeders. Obligate myrmecophily occurs in some genera of the Ptiliidae without being characteristic of any natural group within the family, and apparently without inducing the extreme deviations from the general ptiliid structure.

KEY TO THE GENERA AND MANY OF THE SPECIES OF LIMULODIDAE

1. Antennae with fewer than ten segments (p. 578) ..... Genus **Paralimulodes**
   Antennae ten-segmented 2
2. Antennal scape very long; segments 3–9 of antennae gradually incrassate, antennae not clubbed (p. 579) ..... Genus **Cephaloplectus** 3
   Antennal scape moderately long, antennal segments 3–7 small, segments 8–10 forming a loose club 5
3. Apical margins of elytra sinuate (fig. 32), (p. 583) ..... **C. trilobitoides**
   Apical margins of elytra not sinuate 4
4. Marginal row of spines of the prothoracic tibiae numbering about 42, (p. 582) ..... **C. flavus**

Marginal row of spines of the prothoracic tibiae numbering typically 33–35 (small form, 28–32), (p. 581)..... **C. mus**

5. Pronotal hypomera (anterior to the prothoracic coxae) convex medial to the pronotal margin (p. 584)..... Genus **Eulimulodes**
Pronotal hypomera concave medial to the pronotal margin..... 6

6. Prothoracic tibiae with a row of spines on the outer margins (p. 567), Genus **Limulodes**..... 7
Prothoracic tibiae without a row of spines on the outer margin (p. 578), Genus **Rodwayia**

7. Dorsal surface with rows of long, erect setae in addition to pubescence (p. 573)..... Subgenus **Cephaloplectodes**
Dorsal surface with fine, short, recumbent pubescence only..... 8

8. Elytral apices sinuate (fig. 57), (p. 572)..... Subgenus **Idiolimulodes**
Elytral apices sub-truncate..... 9

9. Head with frontal carina (p. 574)..... Subgenus **Carinolimulodes**..... 10
Head without frontal carina..... 11

10. Emargination of prosternal lobe sinuate (fig. 11); prothoracic tibiae (fig. 81) about twice as long as broad (p. 574)..... **L. (C.) brachyscelis**
Emargination of prosternal lobe not sinuate (fig. 14); prothoracic tibiae (fig. 77) about three times as long as broad (p. 575)..... **L. (C.) philovagans**

11. Scutellum three and one-half times as broad as long; prothoracic tibiae (figs. 78–80) and mesothoracic tibiae (figs. 70–72) differing in chaetotaxy and proportions (p. 575)..... Subgenus **Ecitolimulodes**..... 12
Scutellum six times as broad as long; prothoracic tibiae as in figs. 73–74, and mesothoracic tibiae as in figs. 63–64..... 14

12. Mesothoracic tibiae relatively short and broad (three times as long as broad); mesosternal carina long and slender (fig. 53); prosternal lobe (fig. 13) only moderately broad (p. 575)..... **L. (E.) stenotropis**
Metathoracic tibiae elongate (four times as long as broad); mesosternal carina moderately broad; prosternal lobe (fig. 12) relatively broad..... 13

13. Mesosternal carina as shown in fig. 52 (p. 576)..... **L. (E.) bolivianus**
Mesosternal carina as shown in fig. 56 (p. 576)..... **L. (E.) manni**

14. Mesocoxal capsules contiguous (fig. 2); pubescence of upper surface moderately long; terminal tergite with long setae (p. 568)..... Subgenus **Limulodes**
Mesocoxal capsules separated (fig. 49); pubescence of upper surface short; terminal tergite with setae of moderate length (p. 570) Subgenus **Neolimulodes**

The following species of the family are not included in the above key: Argentina: *Limulodes tibialis* Bruch, *Limulodes argentinus* Bruch, *Limulodes elongatus* Bruch, *Cephaloplectus argentinus* Bruch; Brazil: *Limulodes heyeri* Wasm.; Panama: *Cephaloplectus godmani* Sharp; Mexico: *Limulodes mexicanus* Silv.; Australia: six species of *Rodwayia*.

Genus **Limulodes** Matthews

Limulodes Matthews, 1867, Ann. Lyc. Nat. Hist, N. Y., 8, p. 409.
Limulodes Matthews, 1872, Trich. Illust. et Desc., p. 155.
Limulodes Matthews, 1884, Tran. Amer. Ent. Soc. 11, p. 123.
Limulodes Ganglbauer, 1899, Käfer v. Mitteleuropa 3, p. 296.
Ecitoxenus Wasmann, 1900, Zoöl. Jahrb., Syst. 14, p. 245.
Limulodes (=*Ecitoxenus*) Wasmann, 1908, Zoölogica 11, No. 26, Second Edition, p. 182.
Limulodes Stickney, 1923, Ill. Biol. Monographs 8, No. 1, figs. 31, 177, 324, 469 (head capsule).
Limulodes Park, 1933, Ann. Ent. Soc. Amer. 26, pp. 357–360 (ecology).

Small species, usually less than a millimeter in length (excluding abdomen, which is more or less retracted). Upper surface covered with a fine pilosity, without long erect setae (except in *Cephaloplectodes*). Head (fig. 17) moderately broad, not markedly produced laterally and not "inflated" anteriorly to any extent (fig. 18). Antennal

fossae of moderate depth. Antennae ten-segmented, with a loose, three-segmented club. Pronotum laterally margined from base to apex, the hypomera joining the pronotal disc at an acute angle, more or less concave internal to margin. Mesosternal carina of variable form, always elevated and delimited from the mesosternum. Legs of variable form and chaetotaxy, anterior tibiae bearing a comb of spines on their outer margins.

Genotype.—*Limulodes paradoxus* Matthews.

Remarks.—The limits of the genus *Limulodes* as recognized in this paper are extremely broad and some of subgenera recognized may appear to be worthy of generic rank. It is the opinion of the writers that the material at hand is insufficient for the establishment of a generic classification and that for the present, the course of proposing subgenera to indicate the various degrees of relationship within the genus is a preferable one.

Each of these subgenera is to be considered as a species group, differing from all the others in a certain combination of characters rather than in the possession of any single character. The descriptions of the subgenera serve to call attention to these characters which are for the most part figured and need not be described in full.

Subgenus **Limulodes** *sens. str.*

Antennae as illustrated in fig. 23. Scutellum broadly triangular, approximately six times as broad as long. Mesosternal carina broad, with sub-parallel sides, and with sub-truncate apex. Mesocoxal capsules contiguous internal to the carina. Metasternum little narrowed laterally (fig. 2). Tibiae slender in form, not expanded. Spermatheca in form of a simple loop (fig. 5).

Type of Subgenus.—*Limulodes* (*L.*) *paradoxus* Matthews.

Only one species is included in this subgenus.

Limulodes paradoxus Matthews

Figs. 2, 3, 5, 23, 59–63, 73

Limulodes paradoxus Matthews, 1867, Ann. Lyc. Nat. Hist. N. Y. 8, p. 412, pl. 15, 9 figs. Matthews, 1872, Trichopt. illust., p. 157, tab. 23, fig. 13, pl. 16. Matthews, 1884, Tran. Amer. Ent. Soc. 11, p. 124. Hamilton, 1889, Can. Ent. 21, p. 105 (records). Schwarz, 1890, Proc. Ent. Soc. Wash. 1, p. 244 (host record). Blatchley, 1910, Coleopt. of Indiana, p. 487. Silvestri, 1911, Boll. Lab. Zool. Portici 5, figs. 11, 12.

Description (based on specimens from Washington, D. C.)—Form broadly oval, convex. Color light brown. Upper surface clothed with very fine, moderately long, pale, recumbent pubescence. Antennae as shown in fig. 23, compressed.

Pronotum overlapping base of elytra, broadest at basal one-third, length at middle two-thirds that of breadth, sides evenly curved to anterior foramen which is more than one-third the width of pronotum. Posterior angles prolonged, fitting humeral elevations of the elytra.

Scutellum very broadly triangular, one-sixth as long as broad, concealed by base of pronotum. Elytra more than two-thirds

as long as broad, lateral margins flattened and somewhat expanded, converging very slightly to the very broadly, somewhat separately rounded apices; epipleurae forming a very acute angle with the elytra.

Abdomen usually telescoped under elytra in dried specimens, but with several apical segments extended beyond elytral apices when in alcohol. Tergites 6–9 uniformly clothed with strong setae, which become longer near apex of each tergite and successively longer towards the apex of the abdomen. The truncate terminal tergite bearing very long setae (equal to length of segment) at its apex and at apex of its ventrally reflexed lateral margins.

Anterior margin of prosternum feebly produced. Prosternal lobe (fig. 2) narrowest between coxae and widest just posterior to the coxae, from which point the sides converge somewhat posteriorly to the narrowly rounded apical angles; apical emargination arcuate.

Mesosternal carina (fig. 2) nearly as broad as visible width of coxae, sides fairly straight, slightly narrower at apex than between coxae. Mesocoxal capsules narrowly contiguous medially. Metasternum sparsely setose on lateral portions; on the median tumid region the setae become successively stronger posteriorly and are quite long and stout on the metasternal process between the hind coxae.

Third abdominal sternite (first visible) with about four somewhat irregular, transverse rows of strong, sub-equal setae. Successive sternites bearing finer setae except for their apical rows. Eighth sternite of female with apical margin arcuately produced; eighth of male shallowly emarginate. Lateral margins of ninth (?) tergite recurved ventrally and enclosing a sub-trapezoidal sclerite (which bears only a pair of fine sub-apical setae). This sclerite margined with a sharply delimited hyaline area which is emarginate at apex. Spermatheca of female as illustrated in fig. 5.

Legs with form and chaetotaxy as in figures 59–63, 73. The comb of spines of the outer margin of anterior tibiae composed of from ten to thirteen spines, with twelve or thirteen spines the usual number in the specimens examined. Inner margin with from five to eight spines in addition to spine at base of apical emargination of tibia. Middle tibia with six or seven spines on inner margin, and, in addition, a series of fewer and smaller submarginal spines on the posterior face.

Length (exclusive of abdomen), 0.76 mm.; width, 0.52 mm.

Material Examined.—District of Columbia: 11 specimens (6 on slides) from Washington (Hubbard, Schwarz coll., U. S. N. M., VIII : 5 : —). *Maryland:* 1 specimen (on slide) from near Plummer's Island (H. S. Barber coll., U. S. N. M., X : 7 : 33), 6 specimens (3 on slides) from Linden (J. E. Benedict coll., U. S. N. M., VII : 31 : 19). *Massachusetts:* 9 specimens (1 on slide) from Dracut (M. C. Z.), 2 specimens (1 on slide) from Tyngsboro (M. C. Z.). *Kentucky:* 12 specimens (5 on slides) from Elizabethtown (O. Park coll., IX : 3 : 34). *Arizona:* 5 specimens (3 on slides) from Williams (Barber, Schwarz coll., U. S. N. M., V : 25 : 01), 1 specimen (on slide) from Santa Rita Mts. (Hubbard, Schwarz coll., U. S. N. M., VI : 11 : —).

Hosts.—*Lasius umbratus mixtus* var. *aphidicola* (Walsh); Washington, D. C., and Elizabethtown, Ky., specimens. *Lasius* (*Acanthomyops*) *claviger* (Roger); Maryland (near Plummer's Isld.) specimen. *Lasius* (*Acanthomyops*) sp.; Linden, Md., examples. No host data are available for the Massachusetts and Arizona specimens.

Remarks.—The above redescription of *paradoxus* is based upon specimens from the District of Columbia which is one of the type localities. Matthews originally described this species as having nine-segmented antennae. In addition, the mesosternal carina, as figured, is much more slender in form than in any of the *Limulodes* from the United States before the writers. These and a number of other discrepancies between the specimens at hand and the original description and figures are, in all probability, errors in observation and interpretation due to the difficulty of studying such minute insects, so the writers feel confident that the District of Columbia series represents the same form that was before Matthews.

The specimens from Linden, Maryland, and from Arizona are at present referred to *paradoxus* despite a certain number of rather subtle differences. The six Maryland examples, in particular, seem to differ in their slightly larger size, their pale coloration, the somewhat different form of the apices of the elytra (the sutural angles are slightly rounded in the D. C. examples, right-angled in the Maryland specimens), and in the average chaetotaxy of the inner margins of the front and middle tibiae (spines on the inner margin of the front tibia average eight in the Maryland specimens and a little over six in the D. C. examples; the same averages prevail for the middle tibiae). Additional material is required to determine the significance of these variations.

Neolimulodes new subgenus

Similar in form to subgenus *Limulodes*. Antennae as shown in in fig. 24. Scutellum very broadly triangular, about six times as long as broad. Mesosternal carina (fig. 49) broad and flat, and but little narrowed at apex. Mesocoxal capsules separate internal to the mesosternal carina, connected by a narrow endoskeletal bar. Metasternum but little narrowed laterally (fig. 49). Anterior and middle tibiae (figs. 64, 74) slender, approximately four times as long as broad. Spermatheca as in subgenus *Limulodes*.

Type of Subgenus.—*Limulodes* (*N.*) *parki* n. sp.

Remarks.—This subgenus differs from all of the others in the separation of the mesocoxal capsules. In other respects it seems to be most closely allied to the subgenus *Limulodes*. Only one species is included in the subgenus.

Limulodes parki new species

Figures 4, 8, 17–19, 24, 49, 64, 74

Limulodes paradoxus Wickham, 1892, Psyche 6, p. 322 (Iowa record, with *Aphaenogaster fulva* Rog.). Wickham, 1896, Psyche 7, p. 371 (Iowa record, with *Formica obscuripes* Forel). Park, 1933, Ann. Ent. Soc. Amer. 26, pp. 255–261 (Ecology).

Similar in form and color to *paradoxus* (fig. 4). Antennae as

shown in fig. 24. Pubescence of the upper surface shorter than in *paradoxus*. Prosternal lobe (fig. 8) narrowest between the coxae, rather abruptly broadened to one-half wider behind the coxae, thence converging with nearly straight sides to the apex, which is slightly broader than the intercoxal width. Apical emargination broadly arcuate. Mesosternal carina (fig. 49) slightly broader at middle than the visible width of coxa, its sides nearly straight and parallel to the sub-truncate anterior margin. Mesocoxal capsules not contiguous medially, connected by a transverse endoskeletal bar. Chaetotaxy of abdomen similar, in general, to *paradoxus*, but the setae of segment nine only one-half as long as in the latter. Form and chaetotaxy of legs as in figs. 64, 74. Anterior tibiae with eight to ten spines on the inner margin, and the outer margin with comb of 13–15 spines. Middle tibiae with eight or nine spines on the inner margin. Lamina of the posterior coxa with the lateral portion more prolonged posteriorly than in *paradoxus*.

Length, 0.92 mm. (not including abdomen).

Types.—Holotype, a female, mounted on a slide, in the collection of the writers; collected IV : 15 : 41 at Justice, Cook Co., Illinois, by C. H. Seevers. Paratypes: 65 specimens, same data as the holotype, collected by C. H. Seevers from five colonies of ants located in the same meadow, and distributed as follows: 47 in the collection of the writers, 10 in the U. S. N. M., 2 in the Amer. Mus. Nat. Hist., 4 in the collection of Orlando Park, and 2 in the Mus. of Comp. Zoology. Ten additional paratypes, same data as holotype, collected by R. L. Wenzel, are in the Field Museum of Natural History.

Host of the Type Specimens.—Aphaenogaster fulva aquia Emery.

Other Material Examined.—Illinois: 3 specimens from Argo, Cook Co. (C. Seevers coll., IV : 28 : 38), 8 specimens (4 on slides) from Champaign (O. Park coll., V : 22 : 33, VIII : 8 : 32), 4 specimens (1 on slide) from Peoria (O. Park coll., V : 28 : 33, X : 1 : 33), and 3 specimens (1 on slide) from southern Illinois (M. C. Z. coll.). *Indiana:* 4 specimens (1 on slide) from Valparaiso (M. Talbot coll., IV : 28 : 34). *Iowa:* 20 specimens (5 on slides) from Iowa City (Wickham coll., U. S. N. M., IV : 18 : —, V : 8 : —). *Texas:* 6 specimens (3 on slides) from San Antonio (F. C. Pratt coll., U. S. N. M., V : 15 : 06), and 1 specimen (on slide) from Columbus (Wickham coll., U. S. N. M.).

Hosts of the Above Specimens.—Aphaenogaster fulva aquia Emery; Argo, Illinois, Champaign, Illinois, Valparaiso, Indiana, and Iowa City, Iowa; *Leptothorax curvispinosus* Mayr; Peoria, Illinois; *Formica* sp., *rufa* group; Iowa City, Iowa; *Formica rufibarbis* var. *gnava* Buckley: San Antonio, Texas; *Pheidole dentata* Mayr.: Columbus, Texas.

Remarks.—Several references in literature to *L. paradoxus* have been based upon specimens of this new species which have been examined by the writers. *L. parki* is very distinct from that species and can easily be separated from it by the narrowly separated mesocoxal capsules (contiguous in *paradoxus*), the relatively short setae upon the terminal segment of the abdomen, the form of the mesotibiae, and by many other characters.

Idiolimulodes new subgenus

Form more convex than in the subgenus *Limulodes*. Pubescence of upper surface arranged in irregular, transverse rows (fig. 57). Antennae as shown in fig. 25, the two apical segments relatively short and broad. Scutellum triangular, less than four times as broad as long. Apices of the elytra angulately sinuate. Humeral elevations of elytra pronounced. Mesosternal carina (fig. 50) rather narrow in form, sides sub-parallel. Legs with anterior and middle tibiae (figs. 68, 75) slender in form, though proportionately shorter and broader than in subgenus *Limulodes*. Femora of middle legs constricted near base.

Type of the Subgenus.—*Limulodes* (*I.*) *navajo* n. sp.

Remarks.—The angulately-sinuate character of the apices of the elytra serves to separate this subgenus from all other *Limulodes*. In addition, the general form, the distribution of the pubescence on the upper surface, and the unusual form of the middle femora indicate that *Idiolimulodes* occupies a rather isolated position within the genus. Only one species of the subgenus is known.

Limulodes navajo new species

Figures 9, 25, 50, 57, 68, 75

Limulodes paradoxus Wickham, 1892, Psyche 6, p. 322 (locality record).

Form similar to *paradoxus*, but more convex. Color brown. Upper surface clothed with short, very fine pubescence arranged in irregular transverse rows. Antennae as shown in fig. 25. Scutellum broadly triangular, nearly four times as wide as long. Elytra (fig. 57) together a little broader than long, sides converging slightly to the angulately-sinuate apices. Humeral elevations exceptionally prominent. Anterior margin of the prosternum feebly produced. Prosternal lobe (fig. 9) widest immediately posterior to coxae, thence converging feebly with almost straight sides to the acute apical angles; apical emargination deeply, triangulately arcuate. Median portion of prosternum and lobe finely and sparsely pubescent. Mesosternal carina (fig. 50), at middle, more than two-thirds the visible width of the coxae and nearly twice as broad as the apical width; apex emarginate. Mesocoxal capsules broadly contiguous internal to carina. Metasternum with small, sparsely placed setae on lateral portions, its posterior lobe with an apical group of long, very strong setae. Third abdominal sternite (first visible) with about three transverse rows of long, very strong setae. Fourth, fifth, and sixth sternites each with an apical row of less developed setae and with a few small setae intermingled. Seventh and eighth sternites with smaller setae, these increasing in size to the stronger apical row. Posterior margin of eighth sternite sinuately emarginate at the middle in the male. The terminal tergite with ventrally reflexed margins enclosing the ninth sternite, densely setose, setae successively stouter apically. Legs with form and chaetotaxy as in figures 68, 75.

Length, 0.69 mm. (exclusive of abdomen); width, 0.53 mm.

Holotype.—A male, in the United States National Museum collection, from Walnut, Arizona; collected VII : 21 : —, by Wickham.

Host.—Unknown.

Cephaloplectodes new subgenus

Form broader and more depressed than in subgenus *Limulodes*. Dorsal surface with longitudinal rows of long, erect setae in addition to the fine, short, recumbent pubescence. Antennae as shown in fig. 26. Scutellum triangular, less than three times as broad as long. Mesosternal carina (fig. 51) with sides converging to the sub-acute apex. Metasternum rather strongly narrowed laterally (fig. 51). Anterior and middle tibiae (fig. 69, 76) short and broad (approximately two and one-half times as long as broad); the marginal comb of spines of the anterior tibia continued around the apex at an angle of approximately 90 degrees.

Type of Subgenus.—Limulodes (*C.*) *pallidus* n. sp.

Remarks.—This subgenus is strikingly similar in facies to the genus *Cephaloplectus*. The broad depressed form and the presence of rows of long, erect setae upon the dorsal surface are particularly reminiscent of certain species of *Cephaloplectus*. In other characters, particularly head structure, *Cephaloplectodes* falls within the present broad concept of the genus *Limulodes*, where it occupies, however, a distinctly isolated position. Only one species is known.

Limulodes pallidus new species

Figures 10, 26, 51, 58, 69, 76

Form broader and more depressed than that of *paradoxus*. Color pale yellow. Dorsal surface uniformly clothed with short, fine, pale, recumbent pubescence and with long, fine, erect setae intermingled; these are distributed in ten irregular longitudinal rows of about ten setae each. Antennae as shown in fig. 26. Scutellum triangular (fig. 58), less than three times as broad as long. Elytra (fig. 58) nearly three-fourths as broad as long, sides converging very slightly to the very broadly, somewhat separately, rounded apices. Anterior margin of prosternum feebly produced; prosternal lobe (fig. 10), posterior to coxae, becoming nearly twice as broad as intercoxal width, thence converging feebly, with straight sides, to the very acute apical angles. Apical emargination deep, arcuate. Mesosternal carina narrowly triangular in form, more abruptly narrowed just before the slightly rounded apex. Third sternite with two transverse rows of similar setae; sternites 4–6 each with an apical row of strong setae (which diminish in size on each successive segment) and two or three transverse, irregular, sub-apical rows of much smaller setae; sternites seven and eight clothed uniformly with small, stout setae which increase in size toward the apex of each segment; reflexed margins of ninth tergite with stout, long (especially toward apex) setae. Form and chaetotaxy of legs as in figs. 69, 76.

Length, 0.88 mm. (exclusive of abdomen).

Types.—Holotype, a male, in the U. S. N. M. collection, from Guadalajara, Jalisco, Mexico; collected in December by W. M. Mann. Paratype, a male, same data as the type, deposited in the collection of the writers.

Host.—Eciton (*Acamatus*) sp.

Carinolimulodes new subgenus

Form of subgenus *Limulodes*. Antennae as shown in fig. 29. Margins of lateral expansions of head continued as a carina across the front, separating a sharply declivous transverse anterior area from the dorsum. Scutellum triangular, transverse, approximately five times as broad as long. Anterior margin of prosternum more distinctly produced than in the other *Limulodes*. Prosternal lobe with sub-parallel sides, apical emargination shallow. Mesosternal carina (figs. 54, 55) moderately broad, apex broad, shallowly emarginate. Metasternum little narrowed laterally.

Type of Subgenus.—*Limulodes* (*C.*) *brachyscelis* n. sp.

Remarks.— This subgenus is proposed for two new species, *brachyscelis* from Panama and *philovagans* from Ecuador, which differ most strikingly from the other species in possessing the frontal carina. In a number of other characters (especially the form of the tibiae), the two species show a marked degree of structural divergence.

Limulodes brachyscelis new species

Figures 11, 29, 54, 65, 66, 81

Antennae illustrated in fig. 29. Scutellum broadly triangular, about five times as broad as long. Anterior margin of prosternum distinctly produced. Prosternal lobe (fig. 11) two-fifths broader than intercoxal width, thence with straight almost parallel sides to the acute apical angles; apical emargination shallow, bisinuate. Mesosternal carina (fig. 54), at middle, broader than visible width of coxa, sides converging anteriorly to the emarginate apex, which is about three-fifths the median width of carina. Mesocoxal capsules narrowly contiguous internal to mesosternal carina. Metasternum finely and sparsely setose laterally, median lobe with long, strong setae. Third sternite (first visible) with several transverse, irregular rows of strong setae; sternites 4–8 with an apical row of strong setae which successively diminish in size, and a row of small sub-apical setae which increase in size on each successive sternite; reflexed margins of the terminal tergite closely clothed with long, stout setae. Form and chaetotaxy of tibiae as in figs. 65, 66, 81.

Length, 0.88 mm. (exclusive of abdomen).

Types.—Holotype, a male (on slide), in the collection of the writers, from Barro Colorado Island, Canal Zone; collected VII : 29 : 36, by Orlando Park. Paratypes, three specimens, same data as type, two in writer's collection, and one in the U. S. N. M. collection.

Host of the Type Specimens.—*Eciton burchelli* Westwood.

Remarks.—These specimens were taken from a mason jar of army ants collected by Dr. O. Park from a huge, overnight "nest" of the ants on Barro Colorado Island. This jar of ants proved quite profitable since a large series of *Cephaloplectus mus* Mann were also taken from it by the writers.

Limulodes philovagans new species

Figures 14, 30, 55, 67, 77

Antennae as in *parki* (fig. 30). Scutellum approximately five times as broad as long. Elytra a little broader than long. Anterior margin of prosternum distinctly, arcuately produced. Prosternal lobe (fig. 14) one and two-thirds as broad posterior to the coxae as the intercoxal width, thence with straight, very feebly converging sides to the acute apical angles; apical emargination shallow, evenly arcuate. Mesosternal carina (fig. 55) about as broad at middle as visible width of coxa, thence with feebly curved sides to the slightly narrower, medially notched, apex. Mesocoxal capsules broadly contiguous internal to the mesosternal carina. Metasternum with chaetotaxy as in *parki*. Chaetotaxy of abdomen as in *parki*. Tibiae with form and chaetotaxy as in figs. 67, 77.

Length, 1.2 mm. (exclusive of abdomen).

Types.—Holotype, a male, in the U. S. N. M. (W. M. Mann collection), from Mera Oriental (30 miles E. N. E.), Ecuador; collected II : 14 : 22, by F. X. Williams. Paratypes, five examples, with the same data as the type, two in the U. S. N. M. collection, and three in the collection of the writers.

Host.—*Eciton vagans* Olivier.

Ecitolimulodes new subgenus

Form similar to that of subgenus *Limulodes*. Scutellum approximately three and one-half times as broad as long. Mesosternum (fig. 53) narrowly carinate, the apex of the carina expanded and feebly notched at middle. Metasternum rather strongly narrowed laterally. Spermatheca of female more complex (fig. 6) than in subgenus *Limulodes* (fig. 5).

Type of the Subgenus.—*Limulodes* (*E.*) *stenotropis* n. sp.

Remarks.—This subgenus is erected for three new species, *stenotropis*, *manni*, and *bolivianus*, which differ from the other species in the genus by the combination of characters mentioned above. No single character can adequately separate them from all of the other subgenera.

Limulodes stenotropis new species

Figures 6, 13, 27, 53, 70, 78

Prosternal lobe one-half broader, posterior to coxae, than intercoxal width, thence with nearly straight, feebly converging sides to the very acute apical angles; apical emargination rather deeply, triangulately arcuate (fig. 13). Mesosternal carina (fig. 53) slightly wider at middle, than visible width of coxae, thence narrowed to the slightly expanded apex, which is about one-third of the median width and feebly emarginate at middle. Lateral portion of metasternum, sparsely clothed with short stout setae; median gibbous portion and posterior lobe with more closely placed long, stout setae. Third sternite (first visible) with long, stout setae, sternites 4–8 with small, closely placed setae on apical half of each sternite; these increase in size apically on each sternite; tergite nine (terminal) bearing long,

strong setae. Posterior margin of sternite 8 shallowly, arcuately emarginate at middle in the male, and with a shallow notch on each side of the median emargination. Form and chaetotaxy of front and middle tibiae as shown in figs. 70, 78. Spermatheca as illustrated by fig. 6.

Length, 0.84 mm. (exclusive of abdomen).

Types.—Holotype, a female (on slide), in the U. S. N. M. collection (Nevermann collection). The types, without data, were almost certainly collected by Nevermann in Costa Rica. Paratypes, nine examples in the U. S. N. M. collection, and six specimens in the collection of the writers.

Host.—Unknown.

Limulodes manni new species

Figures 28, 56, 71, 79

Similar to *stenotropis*, but differing in the following respects: prothoracic tibiae (fig. 79) elongate, more than three times as long as wide (two and one-half times as long as wide in *stenotropis*), the outer marginal comb of the prothoracic tibiae with an average of 19 spines (16 in *stenotropis*), the inner margin with an average of 11 spines (8 in *stenotropis*). The middle tibiae (fig. 71) more elongate than in *stenotropis* and with an average of 12 spines (excluding the apical group) on the inner margin (9 in *stenotropis*). Hind tibiae more than four times as long as wide (approximately three times as long as wide in *stenotropis*).

Length, 0.93 mm. (exclusive of abdomen).

Types.—Holotype, a male (on slide) in the U. S. N. M. (W. M. Mann collection), from Colombiana, Costa Rica; collected III : — : 24. Paratype, a male, same data as the type, deposited in the collection of the writers.

Host.—Unknown.

Limulodes bolivianus new species

Figures 12, 52, 72, 80

This species is very close to *manni*, from which it differs chiefly in the form of the mesosternal carina (fig. 52).

Length, 0.94 mm. (exclusive of abdomen).

Types.—Holotype, a female, in the U. S. N. M. (W. M. Mann collection), from Rio Negro, Rio Beni, Bolivia; collected in January by W. M. Mann. Paratype, a male, same data as the type, deposited in the collection of the writers.

Host.—*Eciton coecum* Latreille.

Subgenus Undetermined

The following five species of *Limulodes* have not been available for study, so it is difficult to place them in the subgenera herein described. There is very little available information concerning these species as most of them are described in very general terms. As pointed out previously, these minute beetles can be studied adequately

only after being placed on slides and examined with the compound microscope. Those species which were described without benefits of this technique are almost complete mysteries. Some of the species were described after studies of slide preparations, but the investigators failed to utilize many of the valuable characters present or described them inadequately. Fortunately, many of these species may be recognized on the basis of locality and host data.

Limulodes heyeri (Wasmann)

Ecitoxenus heyeri Wasmann, 1900, Zoöl. Jahrb., Syst. 14, p. 245, pl. 14, fig. 14.
Limulodes heyeri Wasmann, 1908 (1909), Zoölogica 11, No. 26, Second Edition, p. 182. Silvestri, 1911, Boll. Lab. Zool., Portici 5, p. 187.

Wasmann first assigned this species to the staphylinid subfamily Cephaloplectinae but later referred it to *Limulodes*. The original description is wholly inadequate. It is probable that ***bolivianus*** n. sp. is close to ***heyeri*** since both occur with *Eciton coecum* Latreille. Should these two species prove to belong to the same subgenus, the name *Ecitoxenus* will properly replace *Ecitolimulodes* herein proposed.

Type Locality.—São Leopoldo, Santa Catharina, Brazil.

Host.—*Eciton coecum* Latreille.

Limulodes mexicanus Silvestri

Limulodes mexicanus Silvestri, 1911, Boll. Lab. Zool. Portici 5, p. 186, 14 figs.

Silvestri described this species in a general way and compared it with ***paradoxus***, from which it apparently differs in many respects. Unfortunately, the description and figures are not very helpful in relating this species to the other neotropical forms known to us. The most useful of Silvestri's illustrations are those of the legs, the chaetotaxy of which seems to be moderately well figured. This species may be allied to ***stenotropis*** n. sp. or ***manni*** n. sp from Costa Rica, although this is by no means evident, for the mesothoracic tibiae differ considerably in shape and chaetotaxy. There will probably be little difficulty in recognizing this species when collected, since it occurs with *Cheliomyrmex*, the only other genus of army ants besides *Eciton* in the new world.

Type Locality.—Orizaba, Vera Cruz, Mexico.

Host.—*Cheliomyrmex nortoni* Mayr.

Limulodes argentinus Bruch

Limulodes argentinus Bruch, 1922, Physis 5, p. 299, figs. a, b, c. Bruch, 1924, Physis 7, fig. b.

This species and the following two Argentine species are probably characterized well enough to enable one to determine species from that country, but the descriptions and figures offer little basis for comparison with species at hand. Bruch likens ***argentinus*** to ***paradoxus***, and states that it is considerably different from ***mexicanus*** and ***heyeri*** but gives no explanation of these comparisons.

Type Locality.—Alta Gracia, Córdoba, Argentina.

Host.—*Pheidole triconstricta* var. *ambulans* Emery.

Limulodes elongatus Bruch

Limulodes elongatus Bruch, 1924, Physis 7, p. 229, fig. a (1–6).

This species appears to be unusual enough to be readily recognized. The illustrations of habitus, antennae, and seminal receptacle should prove helpful. The intermediate segments (3–6) of the antennae are elongated rather than being transverse as in most other species. This is a large species, measuring 1.2–1.6 mm. in length.

Type Locality.—Fives Lille, Argentina.

Hosts.—*Acromyrmex* (*A.*) *lundi* Guérin and *Acromyrmex* (*Moellerius*) *heyeri* Forel.

Limulodes tibialis Bruch

Limulodes tibialis Bruch, 1926, Revista Soc. Ent. Argentina 1, No. 2, p. 11, 5 figs.

Type Locality.—Cabana, Argentina.

Host.—*Eciton dulcius jujuyense.*

Genus **Paralimulodes** Bruch

Paralimulodes Bruch, 1919, Physis 4, p. 579, 3 figs.

The writers have not seen specimens of this genus but on the authority of Bruch it differs from *Limulodes* in having fewer antennal segments, antennal form, structure of the prosternum and mesosternum, and in having unarmed tibiae. It is strange that Bruch did not state the exact number of antennal segments present, for it is difficult to determine from the figure whether there are eight or nine. Nor is it easy to determine from the description and figure in just what respects the prosternum and mesosternum differ from those of *Limulodes*. It is of interest to note the unarmed tibiae but with respect to other characteristics, the legs are not well illustrated. It appears that this species is unusual enough to merit the generic rank accorded it by Bruch, but the differences need to be more clearly elucidated for further taxonomic studies.

A single species, *P. wasmanni* Bruch (1919, p. 590) has been described. It was based on two males collected from a colony of the army ant, *Eciton spegazzini* Emery, at La Plata, Argentina.

Genus **Rodwayia** Lea

Rodwayia Lea, Tasmanian Naturalist 1, 1907, p. 14.

A single species (*R. orientalis* Lea) of this Australian genus is before the writers. *Rodwayia* is the only known limulodid genus occurring outside the Americas. Despite its wide geographic isolation, this genus appears to be closely related to the genus *Limulodes* (particularly to the subgenus *Neolimulodes*).

Rodwayia differs from *Limulodes* most notably in the absence of a comb of spines on the outer margin of the tibiae and in the form of the mesosternal carina. The latter is moderately broad, with subparallel sides, and is arcuately produced at apex. In contrast to all the other genera, the carina, just before its apex, is incompletely delimited from the mesosternum; its sides slope gradually to the level of

the mesosternum. The mesocoxal capsules are narrowly separated, a condition noted elsewhere only in *Neolimulodes*. The legs are similar in form (though somewhat shorter and stouter) to *Neolimulodes*, but differ conspicuously in the unusual length of the tarsi which are approximately one-half the length of the tibiae (about one-third the tibial length in *Neolimulodes*). The posterior coxae are separated by approximately two-thirds their width (separated by a distance equal to the coxal width in *Neolimulodes*).

Six species of the genus have been described: *Rodwayia ovata* Lea (1907, p. 15), *Rodwayia occidentalis* Lea (1907, p. 16), *Rodwayia orientalis* Lea (1907, p. 16), *Rodwayia minuta* Lea (1907, p. 16), *Rodwayia intercoxalis* Lea (Tran. Royal Soc. S. Aust. 43, 1919, p. 174, pl. 25, fig. 13), *Rodwayia grandis* Deane (Proc. Linn. Soc. N. S. W. 55, 1930, p. 485, figs. 18, 19). These were collected in various localities in Queensland, Victoria, South Australia, New South Wales, and Tasmania. The available host data are recorded elsewhere in the paper (p. 563).

Genus **Cephaloplectus** Sharp

Cephaloplectus Sharp, 1883, Biol. Cent.-Amer. 1 (2), p. 295.

Head, pronotum and elytra beset with rows of erect setae. Head (fig. 15) very broad, approximately four times as broad as the labrum; the head capsule produced laterally as arcuate lamellae anterior and ventral to the antennal fossae. The strongly "inflated" head capsule (fig. 16) extends considerably beyond the labrum. Anterior arm of tentorium very short (fig. 15). Antennal fossae extremely deep, almost contiguous.

Antennal form distinctive (fig. 15); the arcuate, cylindrical scape very long; the somewhat shorter second segment as long as segments 3–7 combined; segments 3–9 feebly incrassate, the ninth longer than the others; the tenth segment narrower than the preceding and rounded at tip; segments 3–10 compressed.

Labrum transverse, nearly twice as broad as long (width: length : : 13 : 7). Mentum transverse, nearly twice as broad as long, feebly trapezoidal, apical margin moderately arcuate. Maxillary palpi as illustrated in fig. 20.

Mesocoxal capsules contiguous; mesosternal carina triangular, acute at apex. Legs (figs. 36–43) distinctive in form, in the arrangement of spines, and especially in the structure of the tarsi (described in morphological section). Spermatheca (fig. 7) very extensively coiled.

Genotype.—*C. godmani* Sharp.

Remarks.—Although nine species of *Cephaloplectus* have been described or mentioned by name, it is impossible to identify a single one by consulting the literature. The confused status of the species has resulted from inadequate description and from the deplorable practice of assigning names without giving any description at all. We are not able to solve all of the problems encountered but hope to eliminate some of the confusion by a restudy of the Mann types and by regarding Wasmann's species as *nomina nuda*.

It is unfortunate that the identity of the genotype *godmani* cannot be established without reference to the type specimen. Sharp's description of this species is vague and furnishes few clues as to its identity. The validity of *mus* Mann is dependent upon finding it different from *godmani*, for there is no reason at present for regarding it as a distinct species. The writers believe that *mus* will prove to be a synonym of *godmani* but until the type of the latter can be examined, *mus* must be recognized. There seems to be no alternative at the present time to identifying our Panamanian specimens as *mus* if for no other reason than that the types of that species are available for comparison. No attempt will be made to establish *godmani*.

In a paper entitled "Ameisenmimikry," Wasmann (1925, p. 50, 51) referred to three new species of *Cephaloplectus* from Brazil by the names *insignis*, *longiseta*, and *quadriglumis*, noted their lengths, and stated in the preface to the paper that further descriptions of these and many other species of ant guests, mentioned only by name, were to be given in a later work. This subsequent paper, which was to have been entitled "Zur Kenntnis der Gäste von *Atta* und *Eciton*" and which was to have been published in the Memorie della Pontifica Accademia della Scienze Nuovi Lincei, apparently did not appear; the writers have been unable to locate it and Borgmeier (Revista Ent. 1, 1931, p. 355) stated that it was not published. It can only be concluded that the three names mentioned above are *nomina nuda* since the measurements of body length scarcely constitute descriptions.

Bruch tentatively identified Argentine specimens in his collection as *godmani* but pointed out that they differed in minor details from Sharp's description of that species. He suggested that should these specimens prove to be different, the name *argentinus* be applied to them. In spite of the fact that this practice of assigning provisional names is to be discouraged, it is very likely that his specimens are distinct so that the name *argentinus* must be recognized.

The type specimens of *flavus* Mann, *trilobitoides* Mann, and *pusillus* Mann were examined by the writers, and it is our opinion that *pusillus* is a synonym of *trilobitoides*.

Cephaloplectus godmani Sharp

Cephaloplectus godmani Sharp, 1883, Biol. Cent.-Amer. 1 (2), p. 297, pl. IV, fig. 1.

The original description of this species is as follows: "Head scarcely visible, antennae concealed. Thorax very large, hind angles much produced backwards. Elytra not so long and scarcely so broad as thorax, a little narrowed behind, hind angles extremely obtuse, no visible punctation, but an excessively fine transverse rugulosity, in this respect resembling thorax. Hind body paler than anterior parts; dense depressed pubescence. 4 mm." The unique type specimen was collected in the track of *Eciton* in a dense forest near Bugaba, Panama.

The above description is too vague to enable us to identify this species. The size is apparently the most important clue in the description. We have specimens from Panama which we would undoubtedly regard as *godmani* were it not for the fact that they cannot be dis-

tinguished from the type of *mus*. This leads us to believe that *mus* is a synonym of *godmani* but we are unable to corroborate this view.

Cephaloplectus argentinus Bruch

Cephaloplectus godmani (?), provisional name of *argentinus*, Bruch, 1926, Revista Soc. Ent. Argentina 1 (2), p. 4, figs. 1–4.

The identification of the specimens of *Cephaloplectus* from Argentina by Bruch was made with great reluctance since Sharp's description of *godmani* gave him no basis for comparison. Although he suspected that his specimens were different, he did not exactly describe them as new but merely suggested that the name *argentinus* be used in case they should prove to be distinct. Bruch's notes and figures do not offer much aid in determining whether his specimens differ from those that we have before us. Possibly they may be closer to *flavus* than to *godmani* since they are small (2.5 mm. in length) and are pale yellow in color. Its occurrence with different hosts and its wide geographical separation from the Panama species lend some support to the belief that *argentinus* is probably distinct.

Hosts.—*Eciton hetschkoi* Mayr (Alta Gracia, Córdoba, Argentina) and *Eciton dulcius jujuyense* (Cabana, Argentina).

Cephaloplectus mus Mann

Figures 1, 7, 15, 16, 20–22, 31, 33–48

Cephaloplectus mus Mann, 1926, Jour. Wash. Acad. Sci. 16, p. 452.

The conclusions concerning this species must be somewhat tentative since a study of material at hand from Ecuador, Panama, and Costa Rica raises questions which can be answered only by the examination of many more specimens. This was emphasized when an attempt was made to identify a series of 75 specimens of the genus collected by Dr. Orlando Park from a huge cluster of *Eciton burchelli* Westwood hanging from a tree on Barro Colorado Island. This series is readily separated into two groups on the basis of size; the 69 smaller individuals average 2.6 mm. in length and six larger individuals average 3.75 mm. in length. Whatever variation exists in each group is due largely to the degree of contraction of the abdomen and the two groups do not overlap. Careful scrutiny has failed to reveal any qualitative differences between the two groups and there are few indications of quantitative differences other than that of size. The larger individuals resemble very closely the type of *mus* and are identified as that species. The smaller individuals evidently represent a distinct population even though occurring in the same colony of army ants. Without more material from other colonies, we are reluctant to assign the smaller individuals to any special category, so shall regard them tentatively as a small form of *mus*.

Description (Typical form).—Color reddish-brown. Head clothed with recumbent hairs, the pronotum and elytra transversely rugulose and densely pubescent, the pubescence arranged in transverse rows between the fine ridges. Head, pronotum and elytra beset with irregular rows of long, pale setae as follows (since the number of setae in a row is variable, these figures are averages): head with five trans-

verse rows of 10 setae each, pronotum with 11 transverse rows comprised of 12 setae in the apical row and 20 in the basal row, elytra with 10 transverse rows of 10–12 setae. Abdomen without erect setae but rather densely clothed with recumbent hairs, those near the apex longer. Metasternum and third sternite (between metathoracic coxae) beset with many stout, spinose setae, and the terminal abdominal sclerites bear long setae.

Prosternal lobe moderately large, the maximum width is approximately three-tenths as wide as the pronotum. Mesosternal carina moderately stout, apex acute, rounded.

Legs beset with spines and setae as illustrated in figures 39–43. Prothoracic tibia with a comb of short spines along the lateral and apical margins; the total number of spines along both borders is rather constant except for one specimen—33 to 35 as a rule, 42 in an Ecuadorian example. Mesothoracic femora bearing five rather stout spines along the medial border and variable number along the apical border.

Male possessing a comb of spines in the emargination of the eighth sternite.

Length, 3.2–4 mm. (av. 3.75 mm.); length of head, pronotum and elytra, 2.3–2.35 mm.; width of pronotum, 1.82–1.96 mm.

Remarks.—The smaller individuals of ***mus*** appear to differ from typical examples in the following respects, most of which are of a minor nature: the uniformly smaller size, the variation within the two groups is discontinuous; the coloration varies from light reddish-brown to yellowish; the mesosternal carina is slightly more acute at apex and more slender; the prothoracic tibiae bear 28–32 spines in the comb along the lateral and apical margins; the prosternal lobe is only one-fourth as wide as the pronotum; the spines along the medial border of mesothoracic femora are not as strong. Length of small individuals, 2.25–2.9 mm. (av. 2.6 mm.); length of head, pronotum and elytra, 1.68–1.75 mm.; width of pronotum 1.2–1.3 mm.

Material Examined.—Holotype, one paratype and two other examples from Mera Oriental, Ecuador (Mann coll., U. S. N. M.); one specimen from Hamburg Farm, Costa Rica (Nevermann coll., U. S. N. M.); and six large individuals and 69 small examples from Barro Colorado Island, Canal Zone (coll. by O. Park).

Hosts.—***Eciton vagans*** Olivier (Ecuador, Costa Rica); and ***Eciton burchelli*** Westwood (Panama).

Cephaloplectus flavus Mann

Cephaloplectus flavus Mann, 1926, Jour. Wash. Acad. Sci. 16, p. 452.

This species differs from ***mus*** in the following respects: (1) the pale yellowish coloration; ***mus*** is typically reddish-brown although the small form may be almost as pale as ***flavus***. (2) the smaller size; ***mus*** is typically a larger species but the smaller form agrees with ***flavus*** in size. (3) the presence of a row of about 15 setae along the apical margins of the elytra (more easily seen in slide preparations). (4) the prosternal lobe is larger in proportion to the prothorax; the maximum width is approx-

imately one-third the width of the pronotum. (5) the row of spines along the lateral and apical margins of the prothoracic tibiae is comprised of 42 spines; *mus* typically has only 32–35 spines in this row (one example has 42) and the small form bears only 28–32. (6) the arrangement of spines on the mesothoracic femora is somewhat different.

Length, 2.5–2.75 mm.

Material Examined.—One paratype and one other example (slide mount) from Hamburg Farm, Reventazon, Costa Rica (Mann coll., U. S. N. M.).

Host.—Eciton (*Labidus*) *praedator* F. Smith.

Cephaloplectus trilobitoides Mann

Figure 32

Cephaloplectus trilobitoides Mann, 1926, Jour. Wash. Acad. Sci. 16, p. 452.
Cephaloplectus pusillus Mann, 1926, J. Wash. Acad. Sci. 16, p. 453. New synonym.

Color light reddish-brown. Head moderately pubescent, pronotum and elytra densely so, the pubescence in transverse rows. Head, pronotum and elytra bearing long setae in moderately regular rows as follows: head with several transverse rows of five setae each, pronotum and elytra with 10 longitudinal rows and approximately five transverse rows. Metasternum and abdominal segments conspicuously beset with long, rather strong needle-like setae, the subapical setae of the tergites and sternites frequently longer than the segment (several of the setae of the metasternum and third sternite are stout and spinose). The ninth abdominal segment bears a ring of about 16 long, needle-like setae at its base (these setae are as long as the segment), and numerous other shorter setae on sides and apex. Medial border of mesothoracic femora bears a row of submarginal setae but they are very small compared to those of *mus* and *flavus*.

Emargination of prosternal lobe somewhat shallower than in *mus* and *flavus;* the depth of emargination is about one-fourth the width of apex, while in *mus* and *flavus* it is about one-half the width of apex. Apical margin of elytra (fig. 32) transverse for a short distance laterally where it forms almost a right angle with the lateral border, then oblique until near the suture.

Apical margin of eighth sternite incised medially in the male but not bearing comb of spines as in *mus* and *flavus*.

Length, 1.6–2 mm. (variation due to contraction of abdomen); length of head, pronotum and elytra, 1.25 mm.; width of pronotum, 1 mm.

Material Examined.—Holotype from Escuintla, Guatemala (Mann coll., U. S. N. M.); one specimen from Costa Rica (Nevermann coll., U. S. N. M.), identified by writers; and holotype of *C. pusillus* Mann (U. S. N. M.) from Hamburg Farm, Costa Rica.

Host.—Eciton coecum Latreille.

Remarks.—This species is easily distinguished from *mus* and *flavus* by its chaetotaxy, the form of the prosternal lobe, the apical margin of the elytra, and in the absence of the comb of spines from the eighth male sternite.

The writers have concluded, after an examination of the type specimens, that there is no justification for regarding ***pusillus*** as a valid species, since there are no apparent criteria for separating it from ***trilobitoides***. The comparison of the types was not as complete as desired because of the fact that the specimens are mounted on points in such a way as to obscure the detailed structure of several of the legs. Upon first examining the specimens, they appear to differ in the chaetotaxy of the abdomen but these apparent differences vanish when the degree of telescoping of the abdominal segments is taken into consideration, and it is noted that some of the setae are almost hidden in one of the types.

Genus **Eulimulodes** Mann

Eulimulodes Mann, 1926, Jour. Wash. Acad. Sci. 16, p. 453.

Head capsule constructed, in general, like that of *Cephaloplectus*, with deep antennal fossae, and with the roof of the fossa produced laterally. Head broad, three times as wide as the labrum. Labrum trapezoidal, somewhat narrower at apex than base (3 : 5), width at apex approximately equal to the length. Mentum approximately as wide as long.

Antennae similar in form to those of *Limulodes*. Scape not visible in specimens at hand, second segment robust, segments 3–8 small, the eighth broader than the others, ninth segment transverse, tenth a little longer and narrower than the ninth, rounded at apex.

Second segment of the maxillary palpus elongated, the proximal part very slender, while distally it is expanded rather abruptly into a club; the compressed third segment a little longer than the second and rather evenly widened from base to the obliquely truncated apex; fourth segment moderately long, slender.

Prosternum in front of the coxae somewhat longer than in *Cephaloplectus*, while the prosternal lobe is proportionately shorter and broader. Length of prosternal lobe, measured from narrowest point between coxae to the apex, is approximately equal to the maximum width, while in *Cephaloplectus* the lobe is only two-thirds to three-fourths as broad as long (the measurement of breadth in *Eulimulodes* does not include the sides of the lobe which are visibly flanged behind the coxae). Apical emargination of prosternal lobe shallow, about one-half as deep as the width of the apex.

The pronotal hypomera medial to the lateral margin strongly convex before being deflexed dorsad to meet the prosternum; this convexity is continuous with the convexity of the head ventrally. Pronotal margin not visible ventrally but easily seen from side.

Genotype.—*Eulimulodes mexicanus* Mann.

Remarks.—The principal characteristics which distinguish this genus from *Cephaloplectus* may be summarized as follows: the absence of erect setae; antennae of the *Limulodes* type; the form of the second and third segments of the maxillary palpi; the shorter and broader prosternal lobe; the convex pronotal hypomera.

Eulimulodes mexicanus Mann

Eulimulodes mexicanus Mann, 1926, Jour. Wash. Acad. Sci. 16, p. 454.

Color reddish. Head, pronotum and elytra uniformly clothed with recumbent pubescence, the fine hairs arranged in longitudinal rows. Abdomen rather uniformly covered with moderately long, pale setae.

Length, 1.9 mm.; length of head, pronotum, and elytra, 1.5 mm.; width of pronotum, 1.1 mm.

Material Examined.—One paratype from Ixtlán, Nayarit, Mexico (Mann coll., U. S. N. M.).

Host.—Eciton (*Neivamyrmex*) *wheeleri* Emery.

REFERENCES

Bernhauer, Max and **K. Schubert.** 1916. Staphylinidae V. (Subfamilies Termitodiscinae, Pygosteninae, Cephaloplectinae, Tachyporinae). Coleopterorum catalogus, pars 67, pp. 441–498.

Bruch, Carlos. 1919. Un nuevo coleóptero ecitofiló. Physis, 4: 579–582, 3 figs.

1922. Dos nuevos coleópteros mirmecófilos. Physis, 5: 296–300, 2 photos, 12 figs.

1924. Dos nuevos coleópteros mirmecófilos. Physis, 7: 227–231, 8 figs.

1926. Coleópteros mirmecófilos de Córdoba. Rev. Soc. Ent. Argentina, 1: 3–12, figs.

Csiki, Ernö. 1911. Hydroscaphidae, Ptiliidae. Coleopterorum catalogus, pars 32, 61 pp.

Deane, Cedric. 1930. Trichopterygidae of Australia and Tasmania. Proc. Linn. Soc. N. S. Wales, 55: 477–487, 22 figs.

Eichelbaum, F. 1909. Katalog der Staphyliniden-Gattungen. Mem. Soc. Ent. Belgique, 17: 71–280.

Ganglbauer, Ludwig. 1899. Die Käfer von Mitteleuropa. Bd. 3. Familienreihe Staphylinoidea. II. Theil. Trichopterygidae, etc., pp. 292–332.

Hamilton, John. 1888, 1889. Catalogue of the myrmecophilous Coleoptera, with bibliography and notes. Can. Ent., 20: 161–166 (1888), 21: 105–108 (1889).

Lea, A. M. 1907. On a new and remarkable genus of blind beetles from Australia and Tasmania of the family Trichopterygidae. Tasmanian Nat., 1: 14–16.

1919. Notes on some miscellaneous Coleoptera, with description of new species. Tran. R. Soc. S. Aust., 43: 166–261, pl. 25–27.

Mann, W. M. 1926. New neotropical myrmecophiles. Jour. Wash. Acad. Sci., 16: 448–455.

Matthews, A. 1867. Description of a new genus of Trichopterygidae lately discovered in the United States. Ann. Lyc. Nat. Hist. N Y., 8: 406–413, pl. 15, 9 figs.

1872. Trichopterygia illustrata et descripta. London. 188 pp.

1884. Synopsis of North American Trichopterygidae. Tran. Amer. Ent. Soc., 11: 113–156.

Park, Orlando. 1933. Ecological study of the Ptiliid myrmecocole, *Limulodes paradoxus* Matthews. Ann. Ent. Soc. Amer., 26: 357–360, 1 fig.

Scheerpeltz, O. 1933. Staphylinidae VII. Supplementum 1. Coleopterorum catalogus, pars 129, pp. 991–1500.

Schwarz, E. A. 1890. Myrmecophilous Coleoptera found in temperate North America. Proc. Ent. Soc. Wash., 1: 237–247.

Seevers, C. H. 1941. Taxonomic investigations of some termitophilous Staphylinidae of the subfamilies Aleocharinae and Trichopseniinae (new subfamily). Ann. Ent. Soc. Amer., 34: 318–349, 46 figs.

Sharp, D. 1875. On a new genus and species of the family Staphylinidae. Ent. Month. Mag., 12 (old series): 199–202.

1883. Insecta, Coleoptera, Staphylinidae. Biol. Cent. Amer., 1 (2): 145–824.

Silvestri, Filippo. 1911. Contributo alla conoscenza dei Mirmecofili del Messico. Boll. Lab. Zool. Portici, 5: 172–195, 14 figs.

Stickney, F. S. 1923. The head-capsule of Coleoptera. Ill. Biol. Monogr. 8, No. 1: 1–105, 26 pls., 585 figs.

Wasmann, E. 1887. Neue Brasilianische Staphyliniden bei *Eciton hamatum*. Deut. Ent. Zeit., 31: 403–416, pl. 5, 19 figs.

1889. Ueber *Xenocephalus* Wasm. und *Vatesus* Sharp. Deut. Ent. Zeit., 33: 190.

1900. Neue Dorylinengäste aus dem neotropischen und dem äthiopischen Faunengebiet. Zool. Jahrb., Syst., 14: 215–289, pl. 13–14, 21 figs.

1902. Species novae Insectorum termitophilorum, a Dr. F. Silvestri in America meridionali inventae. Boll. Mus. Zool. Torino, 17, No. 427: 1–6.

1908 (1909). Die psychischen Fahigkeiten der Ameisen. Anhang II. Beschreibung neuer myrmekophiler Staphyliniden. Zoölogica 11, No. 26, second edition; pp. 1–190, 5 pl.

1925. Die Ameisenmimikry. Abhand. Theoret. Biol., 19: 1–164.

Wickham, H. F. 1892. Notes on some myrmecophilous Coleoptera. Psyche, 6: 321–323.

1896. On Coleoptera found with ants. Third paper. Psyche, 7: 370–372.

BOOK NOTICES

JOHN RAY, NATURALIST, HIS LIFE AND WORKS, by CHARLES E. RAVEN, D.D. xix and 502 pp., frontispiece portrait. 1942. Octavo, linen bound. Published by THE CAMBRIDGE UNIVERSITY PRESS: for sale by THE MACMILLAN COMPANY, INC., 60 Fifth Ave., New York. Price, $7.00.

For twenty years the writer of this notice has browsed through the literature on the history of entomology. In that twenty years no full or satisfactory life of John Ray, the father of modern taxonomy, could be found. All accounts, when they came to the picture of his times, his home life, personal habits and methods of study were brief to the point of barrenness. On the other hand, all treated John Ray with the utmost respect even to the ultimate distinction of referring to him as the father of modern botany or the father of modern zoology. The reserved English in 1844 paid him the high honor of using his name for a biological society, the Ray Society, organized for the publication of outstanding works in the field of biology.

John Ray (or Wray) was born in 1627 and died in 1705. In this first century of organized science, through the yet widespread shadows of medieval ignorance and even bigotry, his personal figure moves dim and almost spectral; dim it is because of our meagre knowledge of the man John Ray himself and spectral because careful analysis of his extensive treatises on both plants and animals shows a vast first-hand knowledge of forms and an astonishing insight into species relationships *inter se*, of variation, of evolution of form into further forms and the beginnings of a sound classification based on comparative anatomy. In many groups he defined genera and species clearly and used a binomial nomenclature. However, in other groups less well known he used a less concise terminology. The great amount of his first-hand work with plants and animals themselves as shown by his extensive correspondence and publications gave him an accurate insight into the nature of living forms, while in succeeding centuries the recognition of this uninterrupted study covering fifty-five years helped built the respect of later students into the dim figure of a superman. His most extensive work which summarized his knowledge of botany, Historia Plantarum Generalis, 1686, 1688, 1704, comprises 2,860 closely printed folio pages (Nordenskiöld, 1932). It lists all plants known at the time, 18,600 (Singer, 1931). At the death of his wealthy coworker, Willughby, in 1672, Ray turned to zoology. He first rewrote and completed Willughby's Ornithologia (1676), then in 1686 published Willughby's Historia Piscium, in 1693 his own Synopsis Quadrupedum and in 1704 Methodus Insectorum. After his death, 1710, was published Historia Insectorum. During these years he published translations of works of travel, works of a religio-philosophical nature which helped ameliorate the antagonism of theologians to studies of nature, and studies of the English language. Death came while studying British Lepidoptera. He and his daughters bred many species. His notes

describe the larvae and pupae, for he had realized the importance of these in classification (Historia Insectorum, 1710).

The many works, and we note but a few which on every page connote study of the material itself, have come down to us in complete form. They are impressive. Opposed to such masses of evidence the details of his life, his friendships and his connections with science of that day are meagre.

The present author, Charles E. Raven, Doctor of Divinity, has finally built up the intimate picture of John Ray. The style and diction of the present volume will puzzle the usual biologist. Raven explored the archives of many learned societies, museums and libraries for letters and other records of John Ray. He found riches only heretofore suspected. These items he has pieced together and interpreted into a coherent review of John Ray's private life, his relations to other friends and scientists of his time and better yet his methods of work and points of view. John Ray, Naturalist, is a volume with a style and method of exposition seldom found in a scientific treatise. It is a thoroughly documented mass of bits of evidence gathered from all manner of sources. It is the style of an exegesis, a common form of exposition among erudite theologians. It is the form of exposition necessarily imposed by the mass of minute bits of evidence. Only a scholar trained in theological literature of this type could have dug out and used so effectively the scattered facts bearing on Ray's life and works.

We see unfolded the life of a man of tremendous energy who made permanent friendships with everyone whom he contacted. He avoided controversies but never hesitated to write his own views based on direct evidence. He seldom criticised the writings of others but when necessary softened criticism at times by admitting that he himself might be in error on more complete evidence. He was a restless traveler, and at every opportunity was in the field collecting and observing distribution. He dissected animals in the field and made notes on internal anatomy. He was the first on record who studied the food of birds by opening the bird's crop and stomach. Between trips he studied and wrote, at home or in the home of any friend with whom he was staying. His life was a life of friendships, correspondence and continuous study of the material itself. His genius was the ability to recognize and organize valid evidence.—C. H. K.

A REVISION OF THE LIBELLULINE GENUS ERYTHRODIPLAX (ODONATA), by DONALD J. BORROR. Pages xv and 286, 6¼ x 9 inches. 1942. Graduate School Studies, Contributions in Zoology and Entomology, No. 4, Biological Series; Published by THE OHIO STATE UNIVERSITY, Columbus, Ohio.

It is very rarely that a taxonomic monograph reaches the high plane of scholarship exemplified by Dr. Borror's Revision of *Erythrodiplax*. To approach so near to perfection demands of the author not only the utmost accuracy both in the study of material and literature, but also that special combination of gifts which go to make the "born taxonomist," viz., a keen sense of form and an aptitude for comparative analysis, coupled with precision and soundness of judgment.

The dragonflies of the genus *Erythrodiplax* are among the most abundant of neotropical Libellulidae and, although they were ably treated by F. Ris (Cat. Coll. Zool. Selys-Longchamps, 1909–1919), much confusion still remained in the nomenclature and taxonomy of the genus, and much material in a number of collections still awaited critical study. Altogether some 8,000 specimens were examined by Dr. Borror in the preparation of this study, more than half of these belonging to the Williamson collection in the Museum of Zoology, University of Michigan, and about one-fourth to collections in Europe, in which many of the types are preserved.

At the time Dr. Borror commenced his study 24 species of *Erythrodiplax* were recognized. One of these, *E. minuscula* of the Southern States, is now reduced to a subspecies of the widely distributed and variable *E. connata*. Other forms, hitherto regarded as having only subspecific status, have been elevated to the rank of species, e.g., *E. naeva*, formerly considered as a race of the well-known *E. berenice*. The total number of species has been increased to 46 with five additional subspecies.

In the introductory sections of the book full consideration is given not only

to morphological features but also to geographic distribution, the affinities of the genus *Erythrodiplax* and the inter-relations of the species.

Special attention is given to the structure of the penis, as it is in this organ that the most definite and, in some cases, the only positive means of identification are to be found. Other useful characters are met with in the hamuli and genital lobes of the males, the venation, color pattern, form of the hind lobe of the prothorax, spines of the hind femora and vulvar laminae of the female. All of these are copiously illustrated.

The genus *Erythrodiplax* is distinctly neotropical, although a few species have entered the United States, one (*E. berenice*) ranging along the Atlantic Seaboard as far as New England, and two others (*E. umbrata* and *E. connata minuscula*) reaching Ohio. The distributional ranges are grouped into five main regions, most of these being further subdivided. The general distribution of the species in these regions and subdivisions is set forth in Table II and further details are illustrated in a series of very fine maps at the end of the book. These distributional data suggest "the Amazon-Guianian region, more specifically the Amazon Basin, as the probable site of the origin of the genus. . . . The greatest speciation, as indicated by the number of endemic species, has occurred in the southeastern part of South America . . ."

Near relations of *Erythrodiplax* are found in both the Old and New Worlds, but the Old World genera, such as *Diplacodes*, *Brachythemis* and *Trithemis*, to which species of *Erythrodiplax* have often been referred by various authors, differ considerably from the latter in the structure of the penis. The New World genera that appear most nearly related to *Erythrodiplax* are *Erythemis*, *Rhodopygia*, *Micrathyria* and *Uracis*.

The genus *Erythrodiplax* is divided by Borror into 12 groups, several of these containing one or two species only, while three contain 8 or 9 species each. The inter-relations of these species are clearly set forth in text fig. 1.

The key for the identification of the species is a model of taxonomic analysis and, wherever possible, characters common to males and females have been used. Only a few species have been omitted from the key owing to lack of material and inadequacy of the published descriptions. Group characters are fully described so that a repetition of these is avoided in the specific descriptions, which are concise, except in the matter of venation, in which the variations are given both in actual numbers (veins or cells) and in percentages. The seasonal and distributional data are very fully recorded.

As to illustrations, these leave nothing to be desired. There are 41 plates, and, excluding the last 12, which are distributional maps, there are 420 figures, all of which are of the highest excellence. The first 9 plates are from photographs of wings; the remaining figures are line or (in case of color patterns) stipple drawings. Special mention should be made of five plates (90 figures) of penes. Not only are those of each species illustrated but in many cases several figures are given to show the range of specific variation. The wide-ranging and variable *E. connata*, with its three races, is illustrated by no less than 14 figures of penes alone.

Space forbids the enumeration of all the excellent features of this monograph. Suffice it to say that, with two or three others of its kind, such as Hubbell's Monographic Revision of *Ceuthophilus*, it sets a standard in taxonomy which only a few can hope to attain.—E. M. WALKER.

THE FEEDING APPARATUS OF BITING AND DISEASE-CARRYING FLIES: A WARTIME CONTRIBUTION TO MEDICAL ENTOMOLOGY, by R. E. SNODGRASS. Smithsonian Miscellaneous Collections, Vol. 104, No. 1, 51 pages, 125 figures. 1943.

This timely review of the anatomy of the mouthparts of the blood-sucking Diptera covers the following groups: I. Blattidae (for generalized plan of parts); II. Culicidae; III. Psychodidae; IV. Heleidae (punkies); V. Simuliidae; VI. Tabanidae; VII. Rhagionidae; VIII. Asilidae; IX. The Cyclorrhapha (general facts); X. Chloropidae; XI. Muscidae and Glossinidae (tsetse flies); XII. Hippoboscidae, and XIII. Streblidae and Nycteribiidae. It is in the usual elegant style of the many papers published by Snodgrass in the series of the Smithsonian Miscellaneous Collections.—C. H. K.

NOTICE TO MEMBERS AND CONTRIBUTORS

The Annals of the Entomological Society of America, published by the Society quarterly, includes the Proceedings of the Annual Meetings and such papers as may be selected by the Editorial Board.

Papers may be submitted to any member of the Editorial Board and should be as nearly as possible in the form desired as final, typewritten, and illustrations finished complete ready for reproduction. Plates must not exceed 4¼x6¾ inches unless intended to fold. Cuts for illustrations are charged at cost to the author. In general, papers to be accepted must be original, complete and previously unpublished. Authors will be allowed fifty reprints gratis and additional copies at cost to the Society.

The Managing Editor is provided with the most recent address of all paid-up members on record in the Secretary's office for mailing the numbers of the Annals and members failing to receive their numbers should present their complaint to the Managing Editor within four months from the date of the mailing of the issue. After that time the numbers will be furnished only at the regular published rate.

Requests for information as to membership and annual dues of members should be sent to the Secretary-Treasurer, PROF. C. E. MICKEL, Dept. of Entomology, The Farm, University of Minnesota, Saint Paul, Minn.

Communications relating to the ANNALS, and orders for reprints or back numbers, should be addressed to the Managing Editor.

SUBSCRIPTION RATES AND BACK NUMBERS

The regular subscription price for the ANNALS is $5.00 (U. S. money) in the United States and all other countries.

Back volumes and numbers can be secured from the office of the Managing Editor. Volumes 1 to 31, each $4.00, separate issues, $1.00 each; Vols. 32 to 35, each will be $5.00, separate issues $1.25 each. Checks, drafts or money orders should be drawn payable to ANNALS ENTOMOLOGICAL SOCIETY OF AMERICA, and addressed to CLARENCE H. KENNEDY, Ohio State University, Columbus, Ohio, U. S. A.

THE THOMAS SAY FOUNDATION

VOL. I.—*Sarcophaga and Allies of North America* . . Price, $3.00
By J. M. ALDRICH

VOL. II.—*Plecoptera or Stoneflies of North America* . . 5.00
By J. G. NEEDHAM and P. W. CLAASSEN

VOL. III.—*Plecoptera Nymphs of North America* . . . 4.00
By P. W. CLAASSEN

Send orders to J. J. DAVIS, Purdue University, Lafayette, Indiana.

Orders outside the United States, Canada, Mexico and U. S. Possessions, 50 cents extra per volume.

All accounts with the Entomological Society of America, or its Journal, "The Annals," owing by individuals or institutions without the United States should be paid by Postal Money Order in American Dollars.

CONTENTS OF THIS NUMBER

PAGE

BOHART, RICHARD M.—New Species of Halictophagus with a Key to the Genus in North America (Strepsiptera, Halictophagidae) 341

MACSWAIN, J. W.—The Primary Larva and Systematic Position of the Meloid Genus Poreospasta (Coleoptera) 360

JAMES, MAURICE T.—Studies in Neotropical Stratiomyidae (Diptera). V. The Classification of the Rhaphiocerinae 365

JAMES, MAURICE T.—Studies in Neotropical Stratiomyidae (Diptera). VI. A New Genus Related to Adoxomyia 380

DEONIER, CHRISTIAN C.—Biology of the Immature Stages of the Clear Lake Gnat (Diptera, Culicidae) 383

NEVIN, F. REESE—*Caeculus pettiti*, a New Species of Mite from Virginia 389

BEQUAERT, J. C.—A New Species of Polybia from Panama (Hymenoptera, Vespidae) 394

ROTH, LOUIS M.—Studies on the Gaseous Secretion of *Tribolium confusum* Duval. II. The Odoriferous Glands of *Tribolium confusum* 397

FLUKE, C. L.—A New Genus and New Species of Syrphidae (Diptera) from Ecuador 425

WOOLLEY, TYLER A.—The Metamorphosis of the Nervous System of *Aedes dorsalis* Meigen (Diptera: Culicidae) 432

The C. V. Riley Centennial Exhibition, Museum of National Expansion, St. Louis 447

DELONG, DWIGHT M.—A New Genus—Stoneana—and Three New Species of Mexican Leafhoppers (Homoptera: Cicadellidae) 448

KROMBEIN, KARL V.—A New Philippine Nipponony sson with Remarks on the Affinities of the Genus (Hymenoptera: Nyssonidae) 451

FUNKHOUSER, W. D.—Membracidae of Guatemala 455

MOORE, WARREN—Some Vitamin Requirements of Black Carpet Beetles, *Attagenus* (?) spp. (Coleoptera: Dermestidae) 483

CHAMBERLIN, JOSEPH C.—The Taxonomy of the False Scorpion Genus Synsphyronus with Remarks on the Sporadic Loss of Stability in Generally Constant Morphological Characters (Arachnida: Chelonethida) 486

SABROSKY, CURTIS W.—New Genera and Species of Asteiidae (Diptera), with a Review of the Family in the Americas 501

RAU, PHIL—The Nesting Habits of Mexican Social and Solitary Wasps of the Family Vespidae 515

BENDER, JOSEPH CHRYSTAL—Anatomy and Histology of the Female Reproductive Organs of *Habrobracon juglandis* (Ashmead (Hymenoptera, Braconidae) 537

SEEVERS, CHARLES H., AND DYBAS, HENRY S.—A Synopsis of the Limulodidae (Coleoptera): A New Family Proposed for Myrmecophiles of the Subfamilies Limulodinae (Ptiliidae) and Cephaloplectinae (Staphylinidae) 546

Book Notices, 359, 364, 382, 431, 454, 482, 485, 500, 514, 536, 545, 586–588

PRINTED IN THE UNITED STATES OF AMERICA
THE SPAHR & GLENN COMPANY, COLUMBUS, OHIO